

## OAPM Study Team Final Report North Texas Metroplex

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## 1 Background

In September 2009, the Federal Aviation Administration (FAA) received the RTCA's Task Force 5 Final Report on Mid-Term NextGen Implementation containing recommendations concerning the top priorities for the implementation of NextGen initiatives. A key component of the RTCA recommendations is the formation of teams leveraging FAA and Industry Performance Based Navigation (PBN) expertise and experience to expedite implementation of optimized airspace and procedures.

Optimization of Airspace and Procedures in the Metroplex (OAPM) is a systematic, integrated, and expedited approach to implementing PBN procedures and associated airspace changes. OAPM was developed in direct response to the recommendations from RTCA's Task Force 5 on the quality, timeliness, and scope of metroplex solutions.

OAPM focuses on a geographic area, rather than a single airport. This approach considers multiple airports and the airspace surrounding a metropolitan area, including all types of operations, as well as connectivity with other metroplexes. OAPM projects will have an expedited life-cycle of approximately three years from planning to implementation.

The expedited timeline of OAPM projects centers on two types of collaborative teams: Study Teams will provide a comprehensive but expeditious front-end strategic look at each major metroplex. Using the results of the Study Teams, Design and Implementation (D & I) Teams will provide a systematic, effective approach to the design, evaluation and implementation of PBN-optimized airspace and procedures. The North Texas Metroplex Prototype Study Team (PST) was one of the first OAPM Study Teams formed.

## 2 Purpose of North Texas PST Effort

The principle objective of the PST was to identify operational issues and propose PBN procedures and/or airspace modifications in order to address them. This OAPM project for the North Texas Metroplex seeks to optimize and add efficiency to the operations of the area. These efficiencies include making better use of existing aircraft equipage by adding Area Navigation (RNAV) procedures, optimizing descent and climb profiles to eliminate or reduce the requirement to level off, segregating arrivals by airport at each corner post to allow for optimal use of Traffic Management Advisor (TMA) at the metroplex's two busiest airports, and adding more configuration-dependent options for RNAV departure procedures to reduce flying miles, among others.

The PST effort is intended as a scoping function. The products of the PST will be used to scope future detailed design efforts and to inform FAA decision-making processes concerning commencement of such design efforts.

## 3 PST Analysis Process

## 3.1 Five Step Process

The North Texas Prototype Study Team followed a five step analysis process:

- 1. Identify and characterize existing issues collaboratively: review current operations and solicit input to obtain an understanding of the broad view of operational challenges in the metroplex.
- 2. Propose conceptual designs and airspace changes that will address the issues and optimize the operation: using an integrated airspace and PBN "toolbox" and technical input from operational stakeholders, explore potential solutions to the identified issues.
- 3. Identify expected benefit, quantitatively and qualitatively, of the conceptual designs: assess the rough-order-of-magnitude impacts of conceptual designs; to the extent possible use objective, quantitative assessments.
- 4. Identify considerations and risks associated with proposed changes: describe, at a high-level, considerations (e.g., if additional feasibility assessments are needed) and/or risks (e.g., if waivers may be needed).
- 5. Document the results from Step 2, Step 3 and Step 4.

Steps 1 and 2 are worked cooperatively and collaboratively with local facilities and operators through a series of outreach meetings. Step 3 is done with the support of the OAPM National Analysis Team (NAT), and the analysis methodology used for the quantitative approach is described in a later section. The NAT is a centralized analysis and modeling capability that is responsible for data collection, visualization, analysis, simulation, and fuel burn modeling. Step 4 is conducted with the support of the OAPM Specialized Expertise Cadre (SEC). The SEC provides "on-call" expertise from multiple FAA Lines of Business, including environmental, safety management, airports, and specific programs (like TMA).

Assessments at this stage in the OAPM process are expected to be high-level, as detailed specific designs (procedural and/or airspace) have not yet been developed. More accurate assessments of benefits, impacts, costs and risk are expected after the Design phase has been completed.

## 3.2 PST Study Area Scope

The North Texas Metroplex consists of airspace delegated to the Dallas/Fort Worth Terminal Radar Approach Control (TRACON) (D10) and the Dallas/Fort Worth Air Route Traffic Control Center (ARTCC) (ZFW). Specific airports within the lateral confines of D10 Class B airspace were selected for proximity and potential interaction with D10 and ZFW operations. The following is a complete list of airports included in this Metroplex Study: Addison Airport (ADS); Fort Worth Alliance Airport (AFW); Dallas Love Field Airport

(DAL); Dallas/Fort Worth International Airport (DFW); Fort Worth Meacham International Airport (FTW); and Fort Worth Naval Air Station JRB/Carswell Field (NFW).

## 3.3 Assumptions and Constraints

OAPM is an optimized approach to integrated airspace and procedures projects, thus the solution space is centered on airspace redesign or procedurally-based, most probably PBN, solutions. The Study Teams are expected to document those issues that cannot or should not be addressed by airspace and procedures solutions, as these will be shared with other appropriate program offices. These issues are described at the end of this report.

The OAPM expedited timeline and focused scope bound airspace and procedures solutions to those that can be achieved without requiring an Environmental Impact Statement (EIS) (e.g. only requiring an Environmental Assessment [EA] or Categorical Exclusion [CATEX]) and within current infrastructure and operating criteria. The Study Team results may also identify airspace and procedures solutions that do not fit within the environmental and criteria boundaries of an OAPM project. These other recommendations then become candidates for other integrated airspace and procedures efforts.

## 3.4 Assessment Methodology

Two types of assessments were made to gauge the potential benefits of proposed solutions: qualitative and quantitative.

Qualitative assessments are those that the PST could not measure, but would certainly result from the implementation of the proposed solution. These assessments included:

- Impact on Air Traffic Control (ATC) task complexity
- Ability to apply procedural separation (e.g., laterally or vertically segregated flows)
- Ability to enhance safety
- Improved connectivity to en route structure
- Improvements to security (avoiding restricted airspace)
- Reduction in communications (cockpit and controller)
- Reduction in need for Traffic Management Initiatives (TMI)
- Improved track predictability and repeatability
- Reduced reliance on ground-based navigational aids (NAVAIDS)

Task complexity, for example, can be lessened through the application of structured PBN procedures versus the use of radar vectors, but quantifying that impact is difficult. Reduced communications between pilot and controller, as well as reduced potential for operational errors, are examples of metrics associated with controller task complexity that were not quantified.

To calculate quantitative assessments, the PST identified changes in track lengths, level flight times, and fuel burn, and compared baseline cases with the proposed changes.

### 3.4.1 Analysis Tools and Techniques

Multiple tools were used to analyze the operations in the North Texas Metroplex, quantify the impact of the identified issues, and estimate the benefits of the proposed solutions.

The Intersect Density Altitude Tool (IDAT) tool determined potential confliction areas between D10 Standard Terminal Arrival Route (STAR) traffic and other traffic flows. This was done to help determine if the level flight segments that were observed in traffic were a result of other crossing traffic in the vicinity.

Performance Data Reporting and Analysis System (PDARS) was used to verify level segments in ZFW airspace.

The Integrated Terminal Research, Analysis and Evaluation Capabilities (iTRAEC) tool was used to identify level segments in both D10 and ZFW airspace, and to determine the location, altitude, and magnitude (in terms of average time in level flight) of those level segments.

Data queries from the Air Traffic Airspace (ATA) Lab were used to determine the number of arrivals over each corner post, for both DFW and DAL prop arrivals, as well as satellite arrivals. It was also used to determine how much traffic exited or entered D10 airspace to the north or south of the TRACON, at or below 12,000 feet, to help assess the feasibility of introducing more traffic into that airspace.

Sector Design and Analysis Tool (SDAT) was used to analyze sector traffic counts, and to visualize traffic.

Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS) was used to create the conceptual airspace and procedure design, as well as to study track data to quantify the difference in distances between published procedures, currently flown tracks, and the proposed conceptual solution procedures.

National Traffic Management Log (NTML) was queried to identify TMIs in the metroplex, and to determine the occurrence and length of FAA playbook routes.

Enhanced Traffic Management System (ETMS) was queried to annualize traffic counts at an airport, including a breakdown of traffic by aircraft type.

Arc Geographic Information System (ArcGIS) generated traffic density charts to identify areas of high traffic concentration, which helped determine which arrival transitions into ZFW have the heaviest amount of traffic.

## 3.4.2 Determining the Number of Operations and Modeled Fleet Mix

Due to the reduced schedule associated with this study effort, there was not sufficient time to model the entire fleet mix that services the North Texas Metroplex airspace. As a result, the metroplex's fleet mix was characterized only by its primary aircraft types. The analysis determined annual operations for the two busiest North Texas Metroplex airports (DFW and

DAL) by examining one year (2009) of FAA's ETMS departures, and assumed the same number of arrivals. When examining the fleet mix servicing the two major North Texas Metroplex airports, the MD8X-series, B73X-series and A319/A320s, and regional jets (Embraer-series and CRJ-series) were found to account for almost 87% of the aircraft types at DFW, and 70% at DAL. The remaining percentage is comprised of multiple aircraft types, each of which individually represent no more than 6.0% at DFW (for example, the B75X-series) and 5.2% at DAL (examples include the C550 and C560).

	DFW Departures* (January 1st - December 31st, 2009)			
	Yearly Counts		%'s of	%'s of
Total #	321,881		Jet Types	All
Total # Jets	303,407			94.3%
	Total # MD80s	130,065	42.9%	
	Total # E145s	98,617	32.5%	
	Total # B73s	34,322	11.3%	
	Total # Other Jets	40,403	13.3%	
Total # TP's	18,474			5.7%

	DAL Departures* (January 1st - December 31st, 2009)			
	Yearly Coun		%'s of	%'s of
Total #	82,102		Jet Types	All
Total # Jets	69,105			84.2%
	Total # MD80s	28	0.0%	
	Total # E145s	4,114	6.0%	
	Total # B73s	44,705	64.7%	
	Total # Other Jets	20,258	29.3%	
Total # TP's	12,997			15.8%

## 3.4.3 Track Data and Profile Analyses

To determine the current level-offs of arrivals in the North Texas Metroplex, the PST examined track data from eight North Flow days and fourteen South Flow days. Using the iTRAEC tool, the PST identified the altitudes where level-offs occurred and the average length of time that aircraft were in level flight at each altitude. Baseline traffic days were selected to identify level-offs:

- North Flow: 27-30 September 2010; 01, 12-14 October 2010
- South Flow: 23-24 September 2010; 4-5, 7-10, 15, 20-22, 24-25 October 2010

The PST Team also used TARGETS to calculate the length of the proposed routes compared to the current routes and actual flown tracks. Track data was obtained for 90th percentile

traffic days during good weather, and consist of four days of North Flow data and five days of South Flow data:

- North Flow: 4 June, 23, 24, 30 September, 2009
- South Flow: 21 May, 4, 5, 6 November, 2009; 18 May 2010

The reduction in time-in-level-flight and the distance savings were then converted into fuel savings by using the European Organization for the Safety of Air Navigation (EUROCONTROL) Base of Aircraft Data (BADA) fuel flow model, taking into account the modeled aircraft fleet mixes at the metroplex airports. The fuel savings were then annualized, assuming a fuel price per gallon of \$2.52. These resulting benefit numbers were the basis for the minimum potential fuel benefit.

The upper bound fuel burn estimates were derived from an actual A320 flight simulator that was used to conduct comparisons between a published STAR as well as a proposed design. Fuel burn per minute in level flight, idle descent, and less-efficient descent were recorded by the simulator. These values were used to validate the relationship between the flight simulator fuel saving estimates and the BADA-based fuel burn estimates (calculated in gallons per nautical mile). The relationship between the BADA and the flight simulator estimates was used to develop the upper bound fuel burn estimates for all of the arrival procedures.

For these traffic days, historical radar track data was used to allow the PST to visualize the flows and identify where short-cuts were routinely applied as well as where flight planned routes were more rigorously followed. The track data was also used as a baseline for the development of several conceptual solutions including PBN routes and procedures. In many cases, the PST generally overlaid the historical radar tracks with PBN routes or procedures to minimize the risk of significant noise impact and an associated EIS. Some of the conceptual arrival and departure procedures contain runway transitions that were included for analysis purposes only. The determination as whether to include runway transitions (e.g., the development of "off the ground" RNAV departures) in the proposed procedures will need to made during the Design and Implementation process.

## 3.4.4 Determining Percent of RNAV Capable Fleet by Airport

The principle objective of the PST was to identify operational issues and propose PBN procedures and/or airspace modifications in order to address them. The PBN Capability Report was used to determine the percent of aircraft at each airport that would benefit from these new procedures. The report determines this percentage by looking at two sources: the equipment suffix of instrument flight rule (IFR) filed aircraft from ETMS and the percent equipped aircraft from a Part 121 avionics database maintained by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD). At the airports studied in the North Texas Metroplex, aircraft had RNAV or Required Navigation Performance (RNP) equipage between 88 and 98 percent, depending on the airport. RNAV equipped capability estimates based on fourth quarter 2009 operations (from ETMS).

	Airport	% of Aircraft RNAV-1, RNAV-2, RNP-1, or RNP-2 equipped
DFW	Dallas/Ft Worth	93%
DAL	Dallas Love	98%
ADS	Addison	88%
AFW	Alliance	90%
FTW	Meacham	94%

## 4 Identified Issues and Proposed Solutions

The section of the report presents the findings and results of the North Texas Metroplex PST effort. It reviews the identified issues, proposed solutions, benefits/impacts/risks, and analysis results in the following areas:

- Arrivals and Departures
  - DFW
  - DAL
  - East Satellites
  - West Satellites
- Terminal Airspace
- En Route Airspace

For each of the of the issue/solution areas, the following topics are discussed:

- Issue characterization
- Proposed solutions recommended by the PST
- Benefits, impacts and risks from an ATC operational/safety perspective and from an airspace user perspective

#### 4.1 DFW Arrivals

### 4.1.1 Identified Issues: Arrivals Share Common Delivery Fixes/Altitudes

- 1. TMA is currently configured and certified for DAL arrivals, but it is not presently in use. The common STARs shared by both DFW and DAL arrivals will impact the effectiveness of TMA for arrivals into both airports. The graphic displays DAL (in blue) and DFW arrivals (in red) over the NW corner post on the BOWIE (UKW) STAR along with additional DAL arrivals that have been placed on the GREGS STAR.
- 2. DAL jet arrivals currently must descend quickly from 11,000 feet (ft) on the DFW west downwind, passing over the top of DFW to avoid DFW departure traffic, and then descend below the DFW east downwind traffic for a straight-in landing on Runway 13 at DAL. This normally requires aircraft to extend landing gear, speed brakes, and/or flaps in order to make this steep descent. Controllers have limited flexibility to adjust the flight path and/or speed of the aircraft for sequencing into DAL because the primary focus of the air crew is to descend the aircraft at an optimal descent rate. Aircraft that are not placed on this procedure are placed on the KNEAD STAR, which adds considerable flight distance at lower altitudes. The graphic depicts DAL arrivals to Runway 13. Aircraft on the JEN STAR are depicted in blue.
- 3. DFW often uses Runway 31 Right (R) as a landing runway when weather conditions permit. The final approach course for DFW Runway 31R and DAL 31 Left (L) are just over 3 nautical miles (NM) apart and DAL arrivals on the UKW STAR must generally be 1,000 ft below the DFW Runway 31R traffic in order to make a left turn into Runway 13L at DAL. The close proximity of the 2 runways, combined with the complexities of descending the DAL arrivals below the DFW Runway 31R arrivals, sometimes requires that D10 place the UKW arrivals on the GREGS STAR. This STAR forces jet arrivals down to low altitudes just outside of Class B airspace. The graphic depicts DAL arrivals to Runway 31 and the DFW Runway 31R final approach course. The black dotted circular area depicts the location in which the DAL Runway 31 arrivals must typically be below the DFW R31R arrivals.
- 4. ZFW is required to manage this merge at DUMPY so that aircraft over ORVLL and YEAGR are separated at DUMPY. However the airspace could be more efficiently managed if these two arrival streams did not merge into a single stream inside D10 airspace. The graphic depicts the merge of the YEAGR and ORVLL transitions over DUMPY. ORVLL and DUMPY are on the boundary of ZFW/D10 airspace.



## North Texas Operational Issues Identified: Arrivals Share Common Delivery Fixes/Alts

#### Issue #1

In-trail delivery of DFW and DAL jet arrivals will not allow full benefit of TMA

#### Issue #2

Shared DFW and DAL JEN9 arrival in South Flow results in steep descents for DAL jets, plus lack of flexibility for controller (limited outs)

#### Issue #3

Shared DFW and DAL UKW STAR for NW DAL arrivals in a North Flow crossing over DFW 31R final results in reduced use of UKW by DAL

#### Issue #4

ORVLL and YEAGR arrival flows, shared by (i.) all DAL arrivals; (ii.) DFW turboprops and props (South Flow only); (iii.) and most East satellite arrivals, merge over DUMPY 10 NM inside D10 boundary







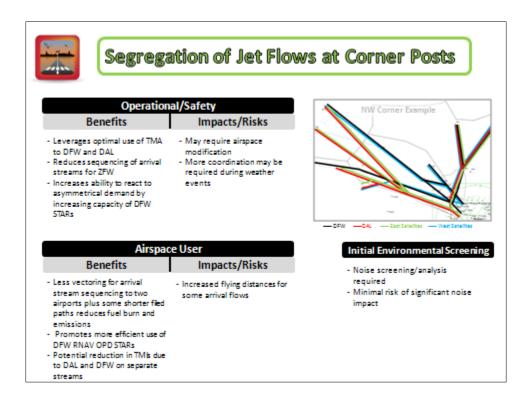


# **4.1.2** Study Team Recommendations: Segregation of Jet Arrival Flows at Corner Posts

The segregation of arrival flows would permit optimization of TMA, enhance the ability to implement Optimized Profile Descent (OPDs) at both DFW and DAL, and allow for the development of more stabilized and efficient DAL arrival procedures. The proposed RNAV STAR design also reduces filed flying miles.

The expected benefits associated with the segregation of arrival flows are described below, while more detail behind the proposed placement of arrival flows is described in upcoming sections of the document.

The following figure describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.



The segregation of flows permits the arrival flow at each airport to be treated separately. With segregated arrival flows, a DAL arrival will not take a slot that a DFW arrival could have used while flying the same STAR, and vice versa. Two STARs will be dedicated to DFW arrivals only; this should be additionally beneficial when demand over corner posts is unbalanced, and it becomes necessary for ZFW to feed the TRACON more heavily over one of the corner posts.

Airspace may have to be modified in the northwest corner post to avoid a ZFW "in/out/in" issue for aircraft on the Tulsa and Will Rogers transitions to the proposed MOTZA STAR (described in upcoming slides). Other airspace modifications and re-allocation will likely be required within D10 airspace as well.

Currently the D10 Feeder controller owns most of the airspace in a corner post. The Metroplex PST proposes that some of this airspace be allocated to D10 satellite controllers (this proposal is described in upcoming slides) to more efficiently manage the proposed DAL arrival routes.

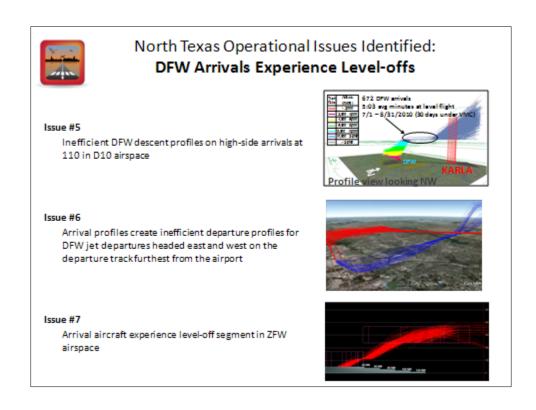
The proposal to segregate arrival flows may increase coordination between both D10 controllers and D10 and ZFW controllers during weather events.

Overall, the proposed routings to segregate flows at the corner posts results in a reduction in flight distance. Specifics for each corner post will be discussed later in the presentation.

An initial environmental screening indicated that segregating jet flows requires a noise screening/analysis; minimal risk of significant noise impact was also indicated.

### 4.1.3 Identified Issues: DFW Arrivals Experience Level-offs

The PST identified three issues related to the descent profiles of DFW arrivals, which are shown in the graphic below. For high-side arrivals that fly a downwind segment, there was a level-off at 11,000 ft for approximately five minutes from all four corner posts. This level segment at 11,000 ft for arrivals created level segments for approximately 10 percent of DFW departures as well, which were held at 10,000 feet until passing underneath the arrival stream. The third issue identified was an inefficient descent in en route airspace, where aircraft leveled at Flight Level (FL) 240.

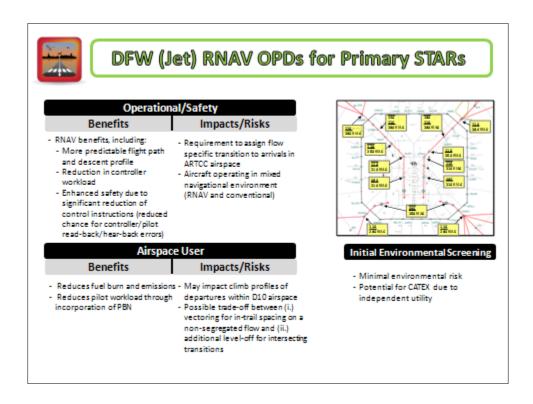


# 4.1.4 Study Team Recommendations: DFW (Jet) RNAV OPDs for Primary STARs

The PST recommends the creation of RNAV OPD STARs on all primary DFW arrival flows at the four corner posts, in order to make the arrivals' vertical profiles more efficient. The OPDs should begin at top of descent in ZFW airspace, and continue within D10.

The expected benefits associated with the introduction OPDs on proposed RNAV STARs into DFW are described below, while more detail behind the proposed altitude windows along the proposed procedures is described in upcoming sections of the document.

The following graphic describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.



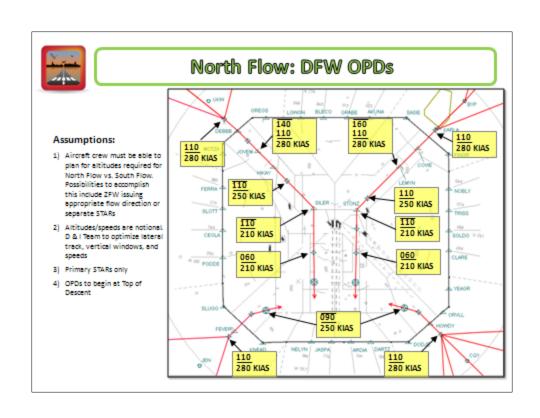
The operational benefits from the proposed DFW OPD STARs include RNAV benefits such as more predictable flight path and descent profiles; reduction in controller workload; and a reduction in the number of control instructions, which in turn reduces the chance for controller/pilot read-back/hear-back errors. An important ATC impact to note is that the OPDs will require ZFW to assign flow specific transitions to arrivals in their airspace. There will also be complexities in dealing with aircraft in a mixed navigational environment, as there will be both RNAV and conventional arrivals.

Airspace users will see a reduction in fuel burn and emissions from the creation of RNAV OPDs. Additionally, the incorporation of PBN will reduce pilot workload. With respect to potential impacts, some climb profiles for departures in D10 airspace may be affected. It is also worth noting that the DFW OPDs introduced in this proposal are only for DFW arrivals that have been segregated from DAL arrivals. There is a possible trade-off between (1) vectoring for in-trail spacing on a non-segregated flow and (2) the potential level-offs for DAL arrival transitions that may intersect DFW arrival transitions in ZFW airspace.

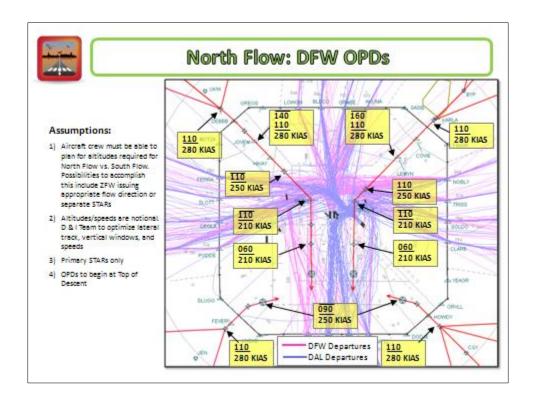
This change is expected to have a minimal environmental risk, with the potential for a CATEX due to independent utility.

#### 4.1.4.1 North Flow: DFW OPDs

The notional design for DFW OPDs shown below includes the set of assumptions to the left the graphic. The notional speeds and altitudes that are part of this proposal are only shown in D10 airspace; however the OPDs are to begin at top of descent. The procedures are designed to work in both North and South Flows, but require that the aircraft crew be able to plan for the correct configuration. At each en route transition merge point outside the D10 boundary, there is an altitude constraint of 11,000 ft or above and 280 knots indicated air speed (KIAS). Within the D10 boundary, the next altitude constraint is dependent upon which flow is in use. In a North Flow, arrivals from the northeast and northwest corner posts are given block altitudes inside D10 airspace, and turn onto the downwind at 11,000 ft and 210 KIAS. Arrivals from the southeast and southwest have an altitude constraint of 9,000 ft approximately 10 NM after entering D10 airspace.

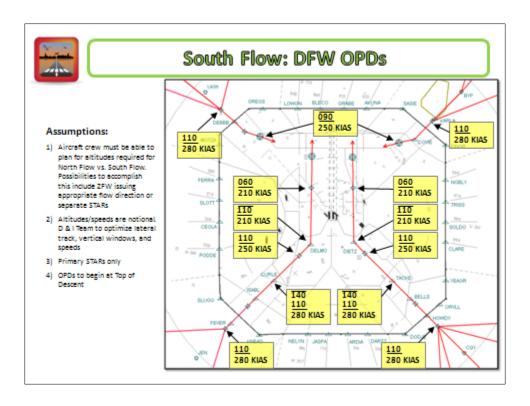


The OPD procedure from the northwest contains a level-off at 11,000 ft before turning onto the downwind in order to accommodate the westbound DAL departures that normally climb above the DFW arrival traffic in this area. There is no level-off required for arrivals from the northeast corner, however, as there is not a significant amount of traffic above these arrivals today. The graphic below depicts the proposed OPD design on a North Flow along with recorded departure tracks from DFW and DAL.

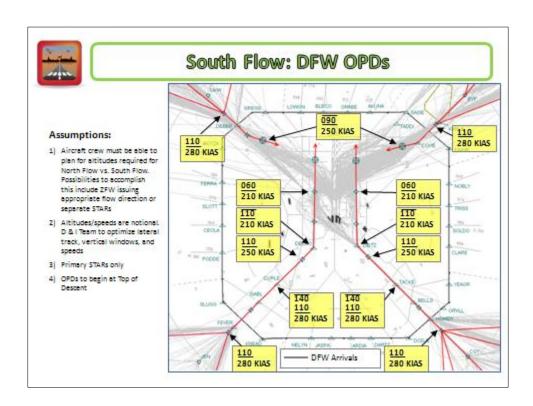


#### 4.1.4.2 South Flow: DFW OPDs

The South Flow OPDs are structured similarly to those in the North Flow, as shown in the graphic below. Arrivals from the southeast and southwest corner posts have a block altitude constraint before turning to downwind, but there is no level segment built into the procedure as there was in the North Flow proposal in the northwest corner, since DAL departures headed west in a South Flow are currently able to climb above the southwest DFW arrival stream at around 16,000 ft. Similar to a North Flow, South Flow high-side arrivals turn onto the downwind at 11,000 ft and low-side arrivals have a 9,000 ft altitude restriction approximately 10 NM after entering D10 airspace.

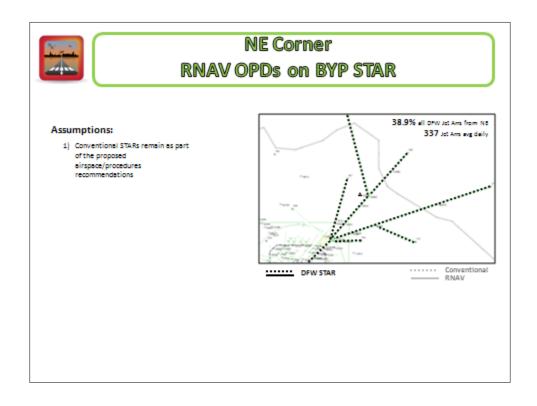


The lateral paths of the proposed RNAV OPD STARs closely follow the current primary arrival tracks, as shown in the graphic below.



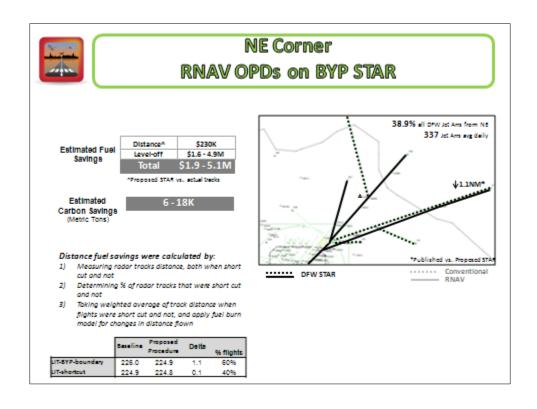
#### 4.1.4.3 NE Corner RNAV OPDs on BYP STAR

The conventional Bonham (BYP) STAR will remain for aircraft that are not RNAV equipped. The BYP STAR is currently the most frequently used at DFW, with 38.9 percent of all DFW jet arrivals entering the TRACON from the northeast, or approximately 337 per day. A depiction of the BYP conventional STAR is shown below.



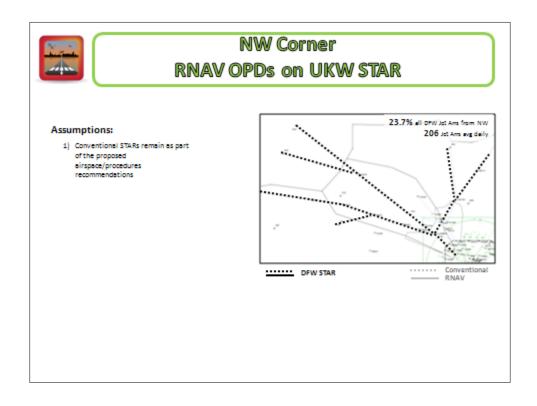
The proposed BYP RNAV OPD STAR overlays the lateral path of the conventional STAR from the Fort Smith (FSM) and McAlester (MLC) transitions, but from the Little Rock (LIT) transition, DFW arrivals are given a more direct route to the D10 boundary. This more direct routing reflects the shortcuts that are often given today. The proposed OPD STAR is 1.1 NM shorter than the currently published STAR. To determine the fuel burn benefit for users from this proposed lateral path change, the proposed procedure was compared to actual flown tracks. Approximately 60 percent of flights today fly a route 1.1 NM longer than the proposed procedure and 40 percent fly a shortcut route, approximately 0.1 NM longer than the proposed procedure. This reduction in distance flown results in an estimated annual fuel burn savings of \$230 thousand (K).

In addition to the savings from reduction in distance flown, the elimination of level segments on the BYP OPD RNAV STAR is estimated to result in a savings of \$1.6 - 4.9 million (M) per year. This results in a total estimated annual savings of \$1.9 - 5.1M, and an estimated annual reduction in CO2 emissions of 6 - 18K metric tons. The proposed procedure, along with a summary of how distance fuel savings were calculated as well as the estimated fuel and carbon savings, are provided in the graphic below.



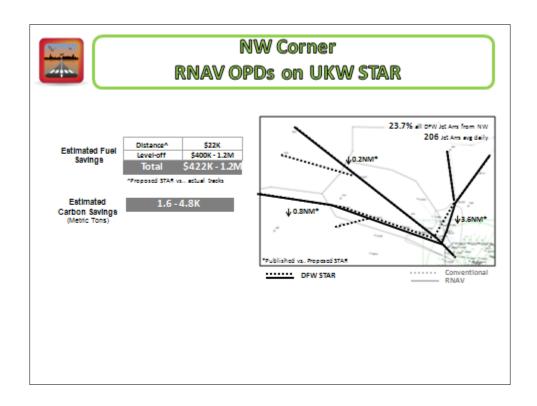
#### 4.1.4.4 NW Corner RNAV OPDs on UKW STAR

The conventional BOWIE (UKW) STAR will remain for aircraft that are not RNAV equipped; the UKW STAR is depicted in the graphic below. The UKW STAR is currently the second most frequently used at DFW, with 23.7 percent of all DFW jet arrivals, or approximately 206 per day.



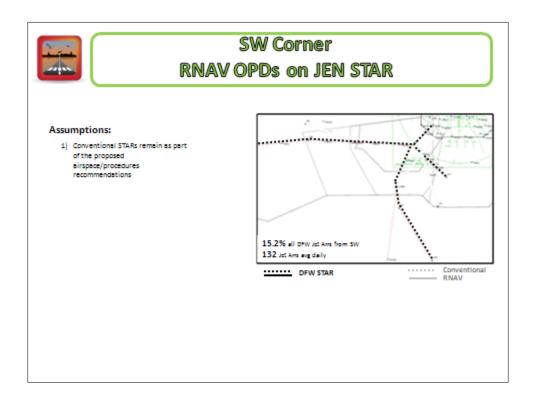
The proposed UKW RNAV OPD STAR provides a more direct routing to the D10 boundary, similar to shortcuts that are often given today. Compared to the currently published STAR transitions, the proposed OPD STAR is 0.8 NM shorter from TEXICO (TXO), 0.2 NM shorter from BORGER (BGD), and 3.6 NM shorter from Will Rogers (IRW) and Tulsa (TUL). As many aircraft today are given shortcuts off the published route, the reduction in distance from the proposed procedure compared to flown tracks is smaller, resulting in an estimated annual fuel burn savings of \$22K.

In addition to the savings from reduction in distance flown, the elimination of level segments on the UKW OPD RNAV STAR is estimated to result in a savings of \$400K - 1.2M per year. This results in a total estimated annual savings of \$422K - 1.2M from the northwest corner post, and an estimated annual reduction in CO2 emissions of 1.6 - 4.8K metric tons. The proposed procedure, along with a summary of the estimated fuel and carbon savings, is shown in the graphic below.



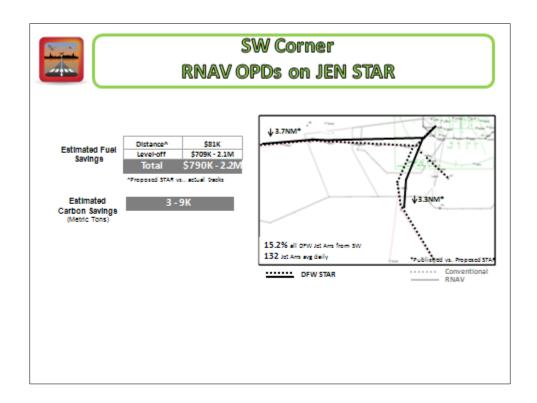
#### 4.1.4.5 SW Corner RNAV OPDs on JEN STAR

The conventional Glen Rose (JEN) STAR will remain for aircraft that are not RNAV equipped. The JEN STAR is currently the least frequently used at DFW, with 15.2 percent of all DFW jet arrivals, or about 132 per day. The JEN STAR is depicted in the graphic below.



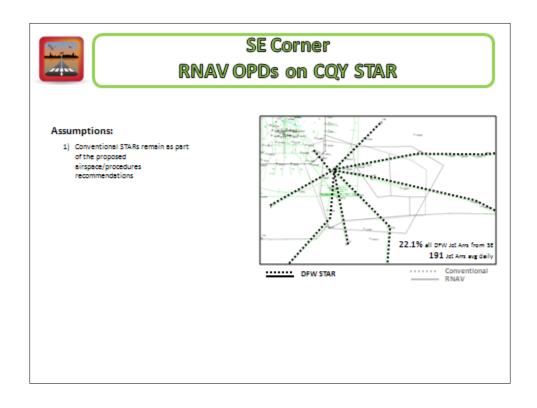
The proposed JEN RNAV OPD STAR provides a more direct routing to the D10 boundary, similar to shortcuts that are often given today. Compared to the currently published STAR transitions, the proposed OPD STAR is 3.7 NM shorter from Wink (INK) and 3.3 NM shorter from Gooch Springs (AGJ). As many aircraft today are given shortcuts off the published route, the reduction in distance from the proposed procedure compared to flown tracks is smaller, resulting in an estimated annual fuel burn savings of \$81K.

In addition to the savings from reduction in distance flown, the elimination of level segments on the JEN OPD RNAV STAR is estimated to result in a savings of \$709K - 2.1M per year. This results in a total estimated annual savings of \$790K - 2.2M, and an estimated annual reduction in CO2 emissions of 3 - 9K metric tons. The proposed procedure, along with a summary of the estimated fuel and carbon savings, is shown in the graphic below.



#### 4.1.4.6 SE Corner RNAV OPDs on CQY STAR

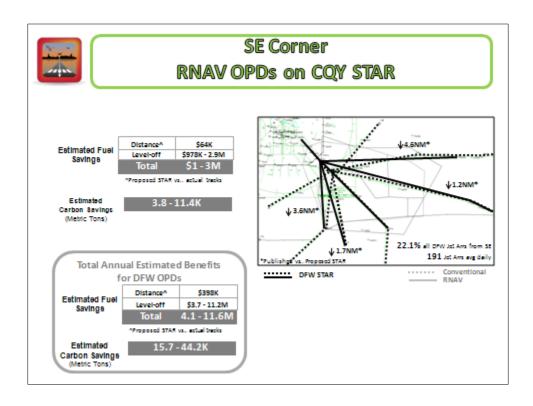
The conventional Cedar Creek (CQY) STAR will remain for aircraft that are not RNAV equipped. The CQY STAR is currently the third most frequently used at DFW, with 22.1 percent of all DFW jet arrivals, or about 191 per day. The conventional CQY procedure is depicted in the graphic below.



The proposed CQY RNAV OPD STAR provides a more direct routing to the D10 boundary, similar to shortcuts that are often given today. Compared to the currently published STAR transitions, the proposed OPD STAR is 3.6 NM shorter from NAVYS, 1.7 NM shorter from Leona (LOA), 1.2 NM shorter from Alexandria (AEX), and 4.6 NM shorter from BEKEN. As many aircraft today are given shortcuts off the published route, the reduction in distance from the proposed procedure compared to flown tracks is smaller, resulting in an estimated annual fuel burn savings of \$64K.

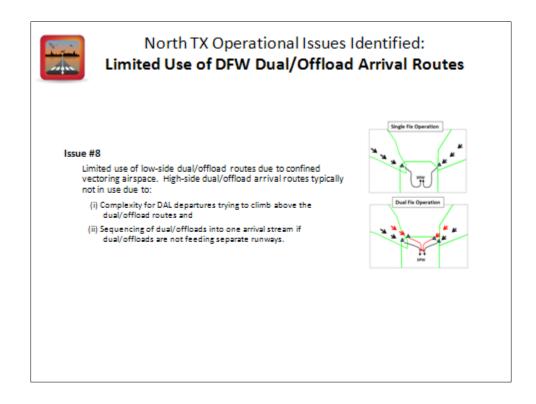
In addition to the savings from reduction in distance flown, the elimination of level segments on the CQY OPD RNAV STAR is estimated to result in a savings of \$978K - 2.9M per year. This results in a total estimated annual savings of \$1 - 3M, and an estimated annual reduction in CO2 emissions of 3.8 - 11.4K metric tons.

The total fuel burn savings from the primary routes on all four corner posts is estimated to be approximately \$398K from a reduction in distance flown, and \$3.7 - 11.2M from a more efficient descent profile. The estimated annual savings from the OPD routes is 4.1 - 11.6M, with an annual reduction in CO2 emissions of 15.7 - 44.2K metric tons. The proposed procedure, along with a summary of the estimated fuel and carbon savings for CQY proposal as well as the proposals at all four corner posts, is shown in the graphic below.



## **4.1.5** Identified Issues: Limited Use of DFW Dual/Offload Arrival Routes

Stakeholders indicated the use of DFW dual STARs on a more consistent basis could help deliver aircraft to the airport at an optimal rate. ZFW identified periods when the use of dual STARs was not permitted by D10, which led to in-trail vectoring in their airspace. D10 advised that the use of dual STARs was often dictated by departure demand from (primarily the east) satellite airports. It is difficult to "top" the arrivals using pre-coordinated climb areas when there are two streams of traffic in this area. D10 also identified the difficulty of merging a dual arrival stream into a single arrival stream in D10 airspace, which is required if the two streams are not feeding separate runways. A summary of this issue along with a supporting graphic is shown below.

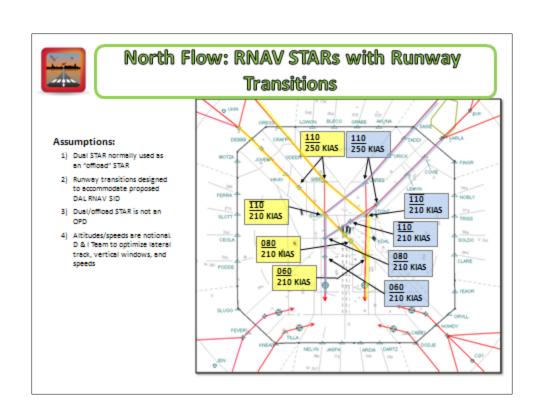


## 4.1.6 Study Team Recommendations: RNAV STARs with Runway Transitions

As described previously, RNAV OPD STARs are proposed for DFW's primary arrival routes. To help mitigate the issue described in the previous section, the PST proposes the introduction of runway transitions on the proposed RNAV OPD STARs in order to more effectively manage high-side dual routes. The RNAV routes and transitions provide more predictable routing, thereby facilitating more predictable management of dual STARs and crossing aircraft from east side to west side, and west to east; incorporate PBN concepts for the stakeholders; result in a reduction in phraseology for controllers; and should allow optimization of TMA on the dual routes.

#### 4.1.6.1 North Flow: RNAV STARs with Runway Transitions

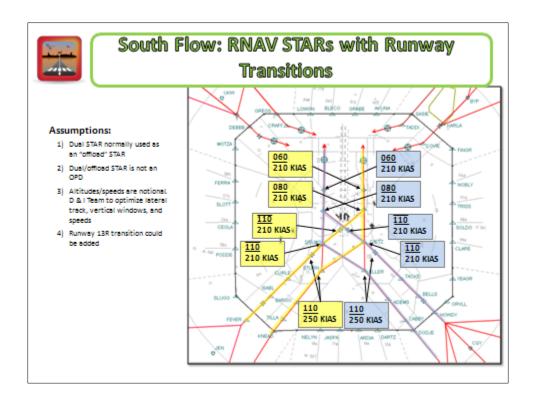
As shown in the graphic below, proposed altitudes have been incorporated in the runway transitions to protect for DFW departures; the proposed MOTZA and SLUGG STARs that transition over the top of DFW at 4,000 and 5,000 ft; and the proposed DAL Runway 31 southbound Standard Instrument Departure (SID). A second concept was discussed that would design the offload STAR to converge with the primary STAR at the point aircraft start the descent on the downwind (STONZ or SILER). This would allow an additional climb area north of DFW for satellite jets to top the arrival streams, and allow the crossover from east to west/west to east to use the same transition as the primary STARs. While this second concept does address the climb area issue, it also places arrivals that are separated at the airspace boundary on converging courses. It is anticipated that in practice controllers would sequence the dual STARs at SILER or STONZ, and then typically send aircraft on the offload STARs direct to these waypoints (WPs) after all conflictions have been resolved.



#### 4.1.6.2 South Flow: RNAV STARs with Runway Transitions

As shown in the graphic below, proposed altitudes have been incorporated in the runway transitions to protect for DFW departures and the proposed MOTZA and SLUGG STARs that transition over the top of DFW at 4,000 and 5,000 ft. A second concept was discussed that would design the offload STAR to converge with the primary STAR at the point aircraft start the descent on the downwind (DELMO or DIETZ). This would allow additional climb area south of DFW for satellite jets to top the arrival streams and allow the crossover from east to west/west to east to use the same transition as the primary STARs. While addressing the climb area issue, this second concept does place arrivals that are separated at the airspace boundary on converging courses. It is anticipated that in practice controllers will sequence the dual STARs at DELMO or DIETZ and controllers would typically send aircraft on the offload STARs direct to these WPs after all conflictions have been resolved.

Aircraft are sometimes flowed from the southeast corner post over the top of DFW for Runway 13R. While not depicted, it is possible to add a transition for this runway.



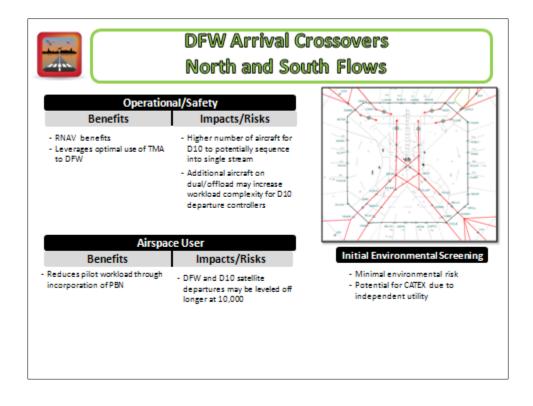
#### 4.1.6.3 Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The addition of runway transitions should decrease feeder controller workload. Currently when aircraft are vectored from one side of the airport to the other, controllers must be very precise with their downwind turns due to traffic in adjacent airspace. Runway transitions permit the controller to focus less on these critical areas, leaving more time to monitor their entire traffic scenario. Pilots receive the benefit of reduced workload because it is a charted procedure available in the flight management computer (FMC). The ability for D10 controllers to more effectively manage dual arrival streams may increase their use and reduce overall delays to the airport.

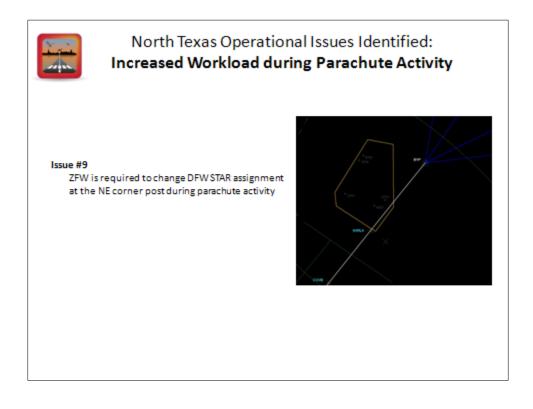
Additional traffic on the high-side offload STARs must be weighed against the impact of climb profiles for satellite airport departures since additional aircraft on dual/offload routes may increase workload complexity for D10 departure controllers. It is imperative that airspace be available for D10 departure controllers to climb the satellite departures above both the DFW departures and arrivals on the high-side STARs. It is anticipated that the predictability of RNAV STARs with runway transitions should help resolve this issue.

This change is expected to have a minimal environmental risk, with the potential for CATEX due to independent utility.



### 4.1.7 Identified Issues: Increased Workload during Parachute Activity

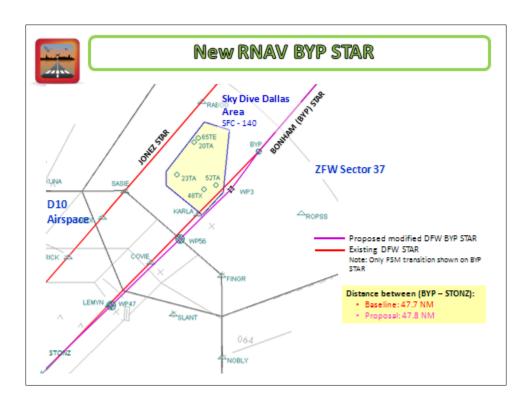
Skydive Dallas operates a sky-diving operation at 14,000 ft and below in an area that encompasses the current BYP STAR. Coordination is accomplished between Skydive Dallas and ZFW for the use of this airspace. When the sky-dive area is active, ZFW controllers must re-clear aircraft from the BYP STAR, which is shown along with the airspace dedicated to the Skydive Dallas operation in the graphic below, to the WILBR STAR to avoid this area. This rerouting creates additional workload on both controllers and pilots.



## 4.1.8 Study Team Recommendations: New RNAV BYP STAR

The PST recommends the creation of a BYP RNAV STAR that does not intersect the Sky Dive Area on either flow, while minimizing additional distance. This solution eliminates the need for ZFW controllers to re-issue a different STAR, and for pilots to program a different STAR in the FMC, whenever the sky-dive area is active.

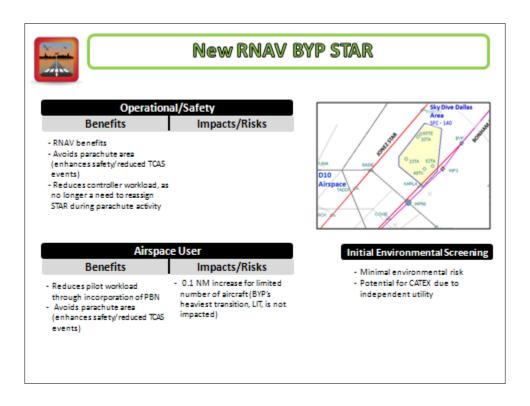
The proposed BYP STAR, depicted below, adds an additional .1 NM for all northeast arrivals except for aircraft on the LIT transition. Traffic on the proposed LIT transition (not depicted), which is the busiest transition at the northeast corner post, is not required to be rerouted to avoid flying over the sky-dive area.



The graphic below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

Airspace user costs were not calculated. A baseline is difficult to determine because the percentage of the time that the sky-dive area was active and the WILBR STAR was issued is not available. The impact of adding approximately 500 ft to some flights was thought to be minimal and the advantages outweighed the additional cost.

This change is expected to have a minimal environmental risk, with the potential for CATEX due to independent utility.

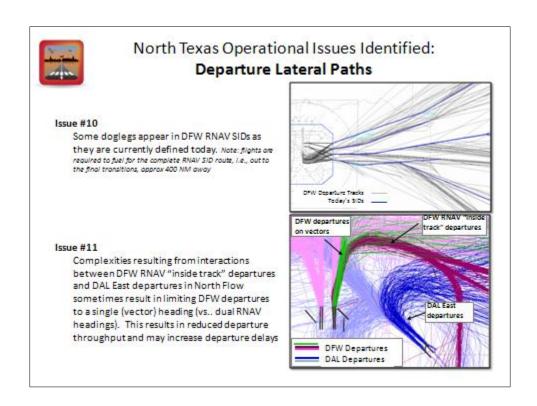


# **4.2 DFW Departures**

# 4.2.1 Identified Issues: Departure Lateral Paths

The figure below for Issue 10 depicts DFW eastbound departures; however, the same issue applies for all D10 jet departures in all directions. The PST specifically focused on eastbound and westbound departure doglegs for benefits quantification, as the doglegs for these departure routes were the most significant. ZFW is currently "short-cutting" the doglegs on filed D10 SIDs on a consistent basis; however, the airlines must fuel departures based on the filed routes. Redesigning the SIDs to reflect the route that is actually flown results in airlines reducing fuel-loading on aircraft, which translates to an overall fuel savings.

With respect to Issue 11, aircraft on the current conventional DAL jet departure SID have the potential to conflict with the DFW "inside track" departures if DAL departures are not vectored off the SID. Eastbound aircraft vectored off the DAL SID also have the potential to conflict with the DFW inside track departures depending on turn rate and controller performance. The interaction between the DFW inside track departures and DAL eastbound departures sometimes results in DFW departures being restricted to a single (vector) departure heading, as opposed to diverging dual RNAV courses. The loss of the dual headings reduces DFW departure throughput.



# 4.2.2 Study Team Recommendations: DFW RNAV SIDS

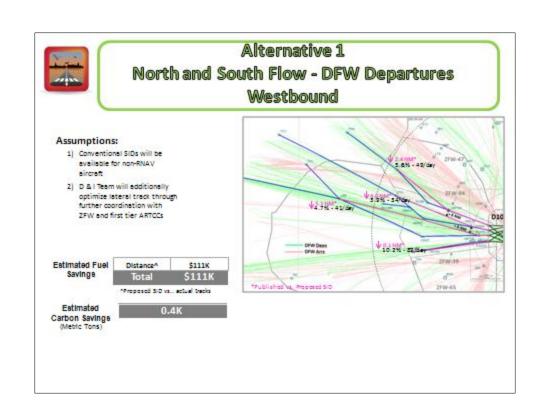
The PST proposed a pair of alternative solutions to address Issues 10 and 11 described above. Both of the proposed alternatives for DFW RNAV SIDs in ZFW airspace reflect the routes that are flown the majority of the time and eliminate most doglegs in ZFW airspace. Both alternatives also call for separating the inside DFW track on a North Flow from eastbound DAL departure traffic. This is accomplished by creating a DAL RNAV SID that meets airspace requirements in the area surrounding DAL and moving the DFW inside track further north to maintain procedural separation with the proposed DAL SID. Moving the inside track north requires that the outside DFW track also be moved further north to maintain separation with the proposed inside track.

The Alternative 1 solution examines the benefits of eliminating the doglegs from RNAV SIDs in ZFW airspace with the current D10/ZFW boundary departure fixes in place. Alternative 2 examines the benefits of eliminating the doglegs while changing the D10/ZFW boundary departure fixes based on North or South Flow. Alternative 2 is known as the "floating departure fix" alternative.

#### 4.2.2.1 Alternative 1 North and South Flow – DFW Departures Westbound

The figure below depicts the DFW westbound SIDs departing the D10/ZFW boundary at the present departure fixes. The blue lines depict the published SIDs and the red lines the proposed SIDs. Green lines reflect actual DFW departure tracks and the pink lines reflect actual DFW arrival tracks. The average daily percentage of DFW departures as well as the average daily traffic count is noted on each route. The pink numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

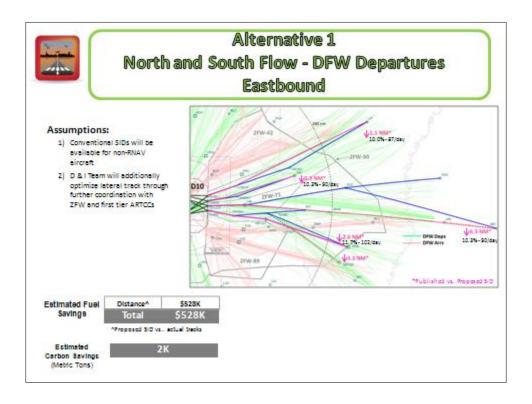
The estimated fuel savings is based on the proposed SIDs versus the actual tracks (not the published SID) that aircraft are presently flying.



#### 4.2.2.2 Alternative 1 North and South Flow – DFW Departures Eastbound

The figure below depicts the DFW westbound SIDs departing the D10/ZFW boundary at the present departure fixes. The blue lines depict the published SIDs and the red lines the proposed SIDs. Green lines reflect actual DFW departure tracks and the pink lines reflect actual DFW arrival tracks. The average daily percentage of DFW departures as well as the average daily traffic count is noted on each route. The pink numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

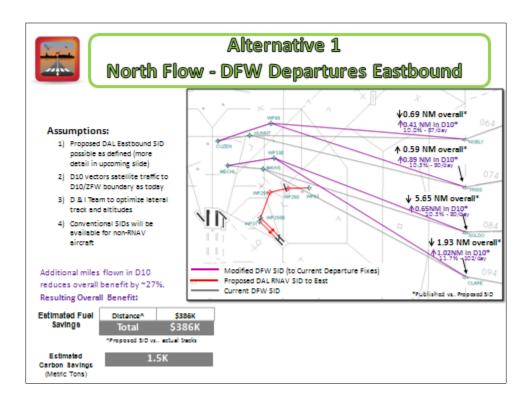
The estimated fuel savings is based on the proposed SIDs versus the actual tracks (not the published SID) that aircraft are presently flying.



#### 4.2.2.3 Alternative 1 North Flow – DFW Departures Eastbound

Both Alternatives 1 and 2 include moving DFW eastbound SIDs north on a North Flow to accommodate the proposal for an DAL eastbound RNAV SID. The shifting of two DFW eastbound SIDs to the north and the creation of the DAL RNAV SID addresses the complex interaction between DAL eastbound and DFW inside track departures, as identified in Issue 11. This complex interaction, along with in-trail requirements, sometimes leads to a DFW departure capacity loss due to the implementation of a single (vector) heading off Runway 35 Center (C) as opposed to the dual RNAV tracks. The proposed DAL eastbound RNAV SID is depicted in red below.

The figure below depicts the current North Flow DFW RNAV SIDs in gray and the proposed DFW RNAV SIDs in purple. The average daily percentage of DFW departures as well as the average daily traffic count is noted on each route. The up arrows reflect an increase in mileage flown and the down arrows a decrease. The purple numbers reflect the mileage impact in D10 airspace while the black numbers indicate the overall mileage impact on the proposed SID versus the published SID. Moving the DFW RNAV SIDs to accommodate the DAL eastbound RNAV SID decreases the overall eastbound benefit in Alternative 1 by approximately 27 percent.

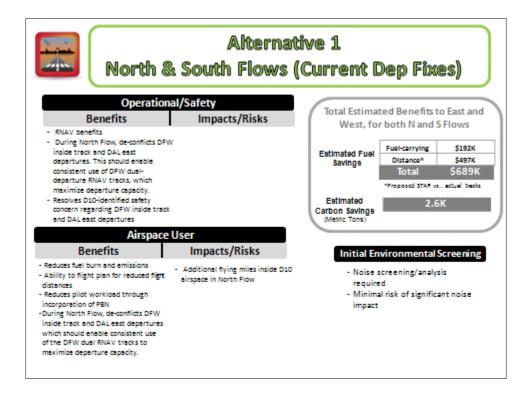


#### 4.2.2.4 Alternative 1 Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

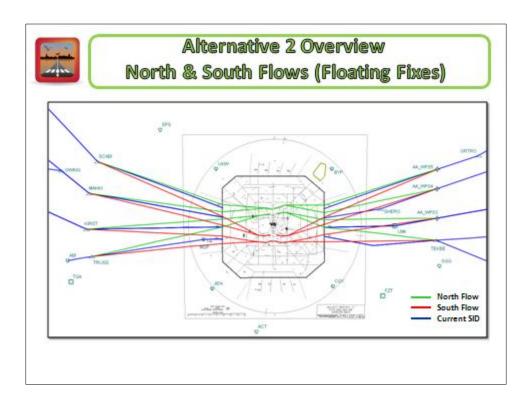
The fuel carrying benefit noted is the fuel savings that is garnered by airlines fueling for the proposed reduced-mileage SID. Even though most aircraft today are shortcut along the SID, they still fuel as if they will fly the entire procedure, carrying excess fuel, which in turn requires additional fuel to carry that excess fuel. The PST used an industry estimate of 10 gallons of fuel required to carry 100 gallons, or a 10 percent cost to carry. The distance difference between the current and proposed procedure was calculated and converted into a fuel savings, which was then multiplied by the 10 percent factor to determine the fuel carrying savings from the proposed procedures.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



### 4.2.2.5 Alternative 2 Overview North and South Flows (Floating Fixes)

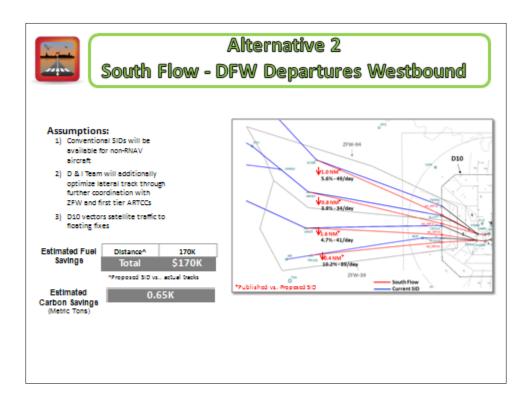
This concept proposes moving all east and west departure fixes to the north in a North Flow and to the south in a South Flow. This movement of fixes shortens the overall flight distance along the proposed DFW RNAV SIDs. The green lines on the graphic below depict the proposed east and west SIDs on a North Flow, and the red lines depict the proposed east and west SIDs on a South Flow. The number of SIDs from DFW will remain the same as today since the proposed North and South Flow SIDs meet at a common fix in ZFW airspace.



#### 4.2.2.6 Alternative 2 South Flow – DFW Departures Westbound

The figure below depicts the proposed DFW westbound SIDs departing the D10/ZFW boundary at the proposed South Flow floating departure fixes. The departure fixes were moved to allow additional mileage savings. The blue lines depict the published SIDs and the red lines the proposed SIDs. The average daily percentage of DFW departures as well as the average daily traffic count are noted on each route. The red numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

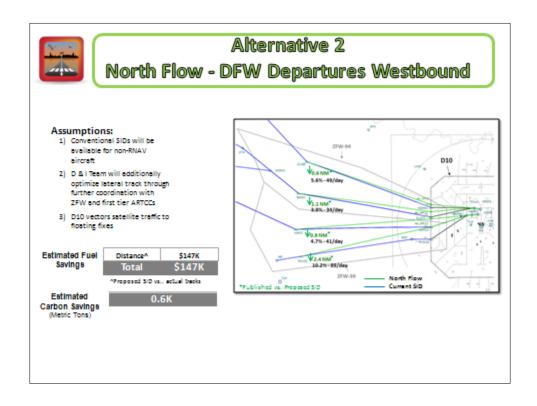
The estimated fuel savings is based on a comparison between the proposed SIDs and actual tracks (not the published SID) that aircraft are presently flying.



#### 4.2.2.7 Alternative 2 North Flow – DFW Departures Westbound

The figure below depicts the proposed DFW westbound SIDs departing the D10/ZFW boundary at the proposed North Flow floating departure fixes. The departure fixes were moved in this proposal to allow additional mileage savings. The blue lines depict the published SIDs and the green lines the proposed SIDs. The average daily percentage of DFW departures as well as the average daily traffic count are noted next to each route. The green numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

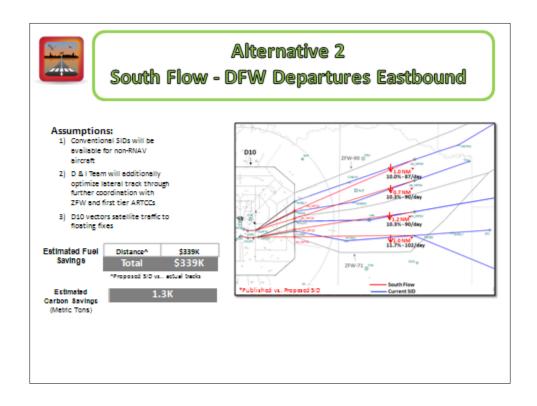
The estimated fuel savings shown in the graphic below is based on a comparison between the proposed SIDs and the actual tracks (not the published SID) that aircraft are presently flying.



#### 4.2.2.8 Alternative 2 South Flow – DFW Departures Eastbound

The figure below depicts the proposed DFW eastbound SIDs departing the D10/ZFW boundary at the proposed South Flow floating departure fixes. The departure fixes were moved in this proposal to allow additional mileage savings. The blue lines depict the published SIDs and the red lines the proposed SIDs. The average daily percentage of DFW departures as well as the average daily traffic count are noted next to each route. The red numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

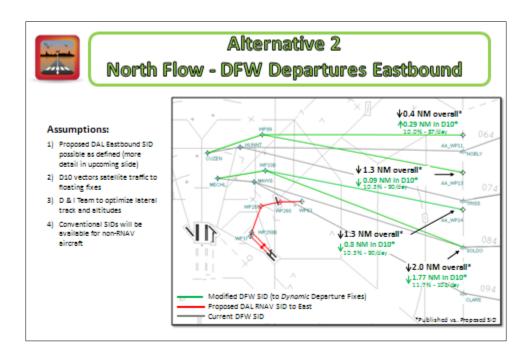
The estimated fuel savings shown in the graphic below is based on a comparison between the proposed SIDs and the actual tracks (not the published SID) that aircraft are presently flying.



#### 4.2.2.9 Alternative 2 North Flow – DFW Departures Eastbound

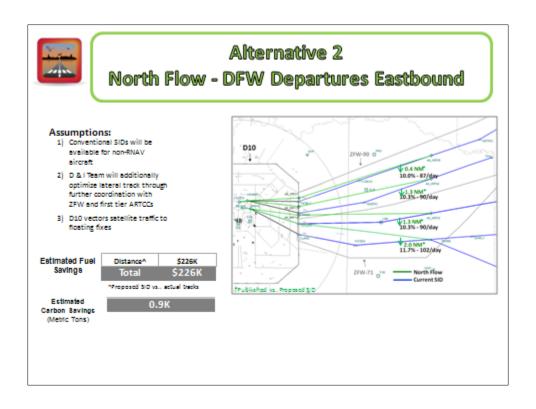
Both Alternatives 1 and 2 include moving DFW eastbound SIDs north on a North Flow to accommodate the proposal for an DAL eastbound RNAV SID. The shifting of two DFW eastbound SIDs to the north and the creation of the DAL RNAV SID addresses the complex interaction between DAL eastbound and DFW inside track departures, as identified in Issue 11. This complex interaction, along with in-trail requirements, sometimes leads to a DFW departure capacity loss due to the implementation of a single (vector) heading off Runway 35 Center (C) as opposed to the dual RNAV tracks.

The figure below depicts the proposed DAL eastbound RNAV SID in red; the current North Flow DFW RNAV SIDs in gray; and the proposed DFW North Flow RNAV floating departure fix SIDs in green. The average daily percentage of DFW departures as well as the average daily traffic count are noted on each route. The up arrows reflect an increase in mileage flown and the down arrows a decrease. The green numbers reflect the floating departure fix mileage impact in D10 airspace while the black numbers indicate the overall floating departure fix mileage impact on the proposed SID versus the published SID.



The figure below depicts the proposed DFW eastbound SIDs departing the D10/ZFW boundary at the proposed North Flow floating departure fixes. The departure fixes were moved in this proposal to allow additional mileage savings. The blue lines depict the published SIDs and the green lines the proposed SIDs. The average daily percentage of DFW departures as well as the average daily traffic count are noted on each route. The green numbers with a down arrow show the mileage savings between the published SIDs and the proposed SIDs. The proposed SIDs are separated by a minimum of 8 NM.

The estimated fuel savings is based on the proposed SIDs versus the actual tracks (not the published SID) that aircraft are presently flying.

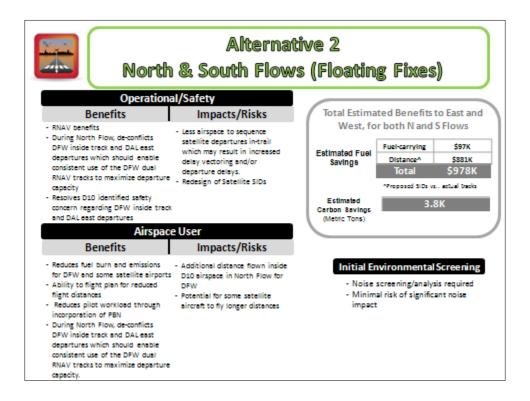


#### 4.2.2.10 Alternative 2 Benefits Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

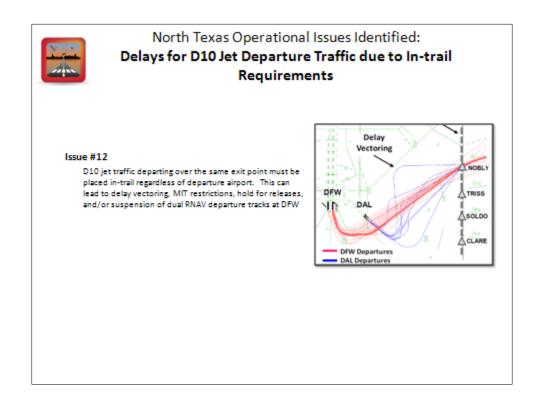
The floating departure fix design would require all DFW and satellite airport SIDs to be redesigned so they depart D10 airspace over the proposed floating departure fixes. However, this reassignment may result in longer flight distances for some satellite airports depending on the relative location of the airport to the proposed floating departure fixes and the percent of time they operate in North or South Flow.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



# **4.2.3** Identified Issues: Delays for D10 Jet Departure Traffic due to In-Trail Requirements

The ZFW/D10 Letter of Agreement (LOA) requires that D10 departing traffic over the same exit fix must be placed in-trail. The D10 departure controller manages this requirement by using a number of different methods depending on departure volume. The graphic below depicts (in blue) DAL and (in red) DFW departures over NOBLY on a South Flow. Delay vectoring to achieve in-trail spacing appears to be occurring in some instances.



# **4.2.4** Study Team Recommendations: Additional Research on Delivery Options

Data were not available during the PST time frame to research Issue 12. Two previous attempts were made without success to implement stacking departures on a regular basis. The first attempt was approximately 10-15 years ago and the second attempt, which only applied to aircraft departing Collin County Regional Airport at McKinney (TKI), took place approximately 4 years ago. The delay impact to airspace users as a result of being sequenced in trail to ZFW is not currently recorded, except when departure delays exceed 15 minutes. Therefore a delay baseline has not been established to allow the comparison between delays for departures being delivered stacked or in trail.

As a result, the PST was not able to recommend a solution to Issue 12. However, the PST does recommend further feasibility analysis be conducted by the D & I Team, in order to examine the trade-offs between alternate methods of D10 departure delivery to ZFW. Such an analysis would require data that is not normally recorded (the first graphic in the next section lists the kinds of data needed). Therefore, the PST recommends that (1) a trial be conducted during which DFW and satellite departures are delivered stacked from D10 to ZFW; and (2) data be collected by D10 when delays are incurred by D10 departures to enable in-trail delivery to ZFW during the stacking trial, as well as when departures are being delivered in trail.

### 4.2.4.1 Information for ZFW and D10 to Collect during Trails

The information shown on the graphic below is required in order to determine which method for departure delivery has the least impact on either ZFW and D10, as well as and the airspace users. There are multiple examples of facilities in the National Airspace System (NAS) that use in-trail delivery, and others that use stacking, while others use dedicated departure routes for particular departure airports. Chicago TRACON uses stacking between Chicago O'Hare International Airport (ORD) and Chicago Midway International Airport (MDW) departures to the south, and separate departure fixes for MDW and ORD departures to the east, while Atlanta TRACON uses in-trail in the same departure transition areas for satellite and Hartsfield-Jackson Atlanta International Airport (ATL) departures. Collecting this data would require a concentrated effort on the part of each facility as most of this information is not currently tracked.



# Information for ZFW and D10 to Collect During Trials

Stacking Departure Fixes	In-trail
Additional vectoring in en route airspace due to a stack or separate departure fixes	Frequency of speed restrictions on D10 departures to achieve in-trail
Speed control to manage stack departure fixes in en route alrepace	Delays both less and greater than 15 minutes, taken at D10 departure airports to achieve in trail inside D10
Extent (and frequency) of level-offe required in D10 and ZFW to routinely manage stacks/separate departure fixes	MITs put in place to achieve in-trail within D10 (and the frequency of this kind of MIT)
Impacts (and frequency) of step-climbs as a result of stacking departure fixes	Frequency of suspension of dual departure tracks in order to achieve in-trail
Evaluation of departure sector capacity at ZFW	Vectoring of departures w/in D10 airspace*

\*Cata analysis available

### 4.2.4.2 Potential Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

Allowing for the delivery of stacked departures (instead of in-trail) between D10 and ZFW would potentially reduce the need to:

- Vector departures in D10 airspace
- Initiate requests for "calls for release" on satellite airport departures (including DAL)
- Switch to a DFW single departure heading on vectors (vs. using diverging headings on RNAV SIDs) and the associated reduction in departure throughput and departure delay
- Coordinate between D10 and ZFW since there would not be a need to coordinate for stacks if it were implemented as the default procedure

However, delivery of stacked departures could result in additional stepped climbs and vectoring of D10 departures in ZFW airspace.

Further analysis is required to understand the operational trade-offs between the current operation of delivering D10 departures in-trail over the same departure fixes vs. allowing stacked departures over the departure fixes.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



# Potential Qualitative Impacts if D10 Jet Departure Traffic No Longer Delivered In-trail

#### Operational/Safety

#### Benefits

#### Impacts/Risks

- Reduction in vectoring for intrail between DFW and satellite
- airports in D10 airspace
   Reduction in ATC coordination between D10 facilities
- Transfer of D10 in-trail issues to

#### Airspace User

#### Benefits

#### Impacts/Risks

- May reduce overall fuel burn and emissions (depending on extent and frequency of step climbs for satellite traffic introduced in ZFW)
- May reduce delays and flight distances for those flights vectored in D10 to achieve intrail

- Departure restrictions required by ZFW may not improve delays or flight distances

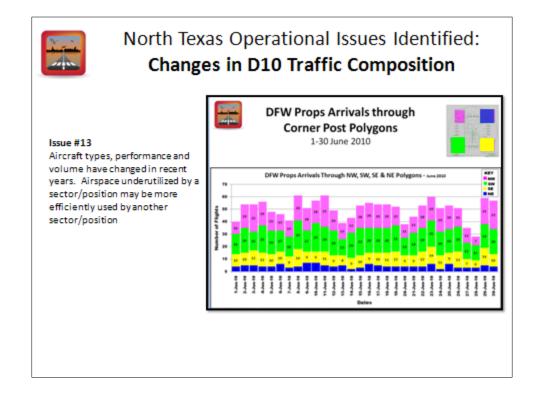
#### Initial Environmental Screening

- Noise screening/analysis required
- Minimal risk of significant noise impact

# 4.3 Terminal Airspace

# 4.3.1 Identified Issues: Changes in D10 Traffic Composition

The figure below depicts the number of DFW propeller driven aircraft (props) transitioning airspace at each corner post. Currently the D10 feeder controller controls these aircraft as well as higher altitude (jet) traffic. Airspace user feedback indicated that satellite and DAL aircraft were required to remain at low altitudes for significant periods of time (especially on the KNEAD and GREGS STARs), were not allowed to consistently conduct practice approaches, and were periodically held on the ground awaiting IFR releases. The intent of the graphic is to show that the number of prop arrivals has decreased due to the introduction of "regional" jets into the NAS. It may be beneficial to restructure airspace in order to permit the satellite controllers to control the prop arrivals and to also be allocated some of the airspace currently owned by the feeder controllers. This may allow satellite and DAL aircraft to remain at higher altitudes longer, and make more altitudes available to satellite controllers in order to facilitate practice approaches and more timely releases.

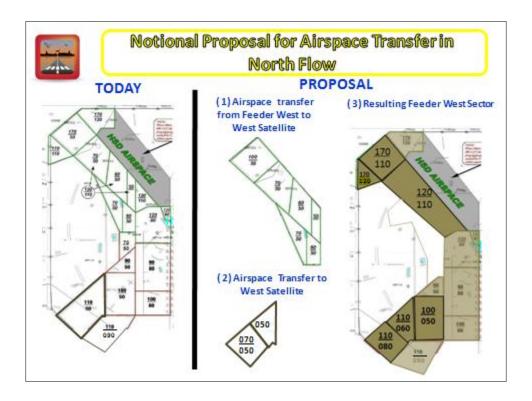


# 4.3.2 Study Team Recommendations: Explore Airspace Re-allocation

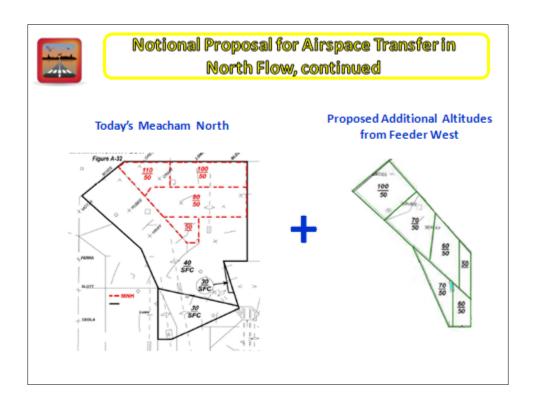
Designing airspace changes requires an intricate knowledge of airspace subtleties and the PST did not feel qualified to introduce a recommended solution. The PST does recommend further feasibility analysis be conducted by the D & I Team, as it appears efficiencies are achievable by examining the current airspace use and reallocating it to more closely reflect today's traffic and demand. Specifically, low-altitude feeder airspace may be more efficiently used by West Satellite positions; additionally, low-side corner post airspace may be redesigned to feed the center runway from the dual/offload DFW STAR, allowing additional altitudes for satellite traffic. The D & I Team should have the time and resources to examine this issue in detail.

#### 4.3.2.1 Notional Proposal for Airspace Transfer in North Flow

The graphic below depicts a specific example of an airspace change over the northwest and southwest corner posts in North Flow. Currently a DFW feeder controller controls both jet and prop aircraft, at the depicted altitudes, on the UKW and JEN STARs. This notional proposal transfers some of the feeder airspace along with the responsibility to control the DFW prop arrivals (an average of 16-19 aircraft per day at each corner post), to satellite controllers. This airspace may be more efficiently used by the satellite controllers as opposed to protecting it for a limited number of DFW prop arrivals each day. It is anticipated that this transfer of airspace will provide additional altitudes for satellite controllers and may address some of the identified airspace user issues.

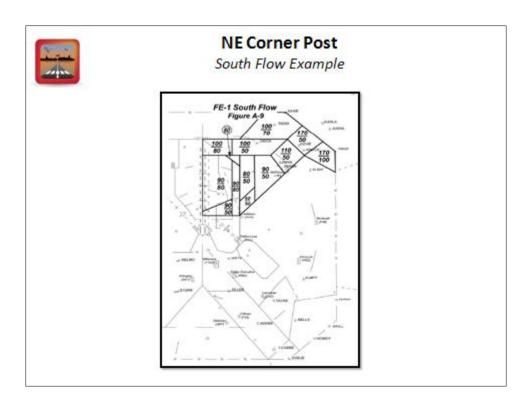


The figure below depicts the incorporation of the (proposed) transferred feeder airspace into the Meacham North satellite sector. The additional airspace and altitudes should permit satellite traffic to remain at higher altitudes for a longer period of time.



### 4.3.2.2 NE Corner Post South Flow Example

It is also recommended that the airspace for the offload arrivals on the low-side corner post be examined. Generally if aircraft are placed on the low-side offload, this traffic is vectored "high and wide" for the middle runway. Even though there does not appear to be a need for this traffic to be descended to 5,000 ft since the ILS turn on altitude is 6,000 ft, airspace at 5,000 ft is allocated for this STAR. The graphic below depicts the northeast corner post, however all corner posts are similarly designed. Re-allocating and re-designing airspace on the low-side corner posts may provide additional satellite altitudes and provide relief for the "long and low" portion of the satellite STARs.

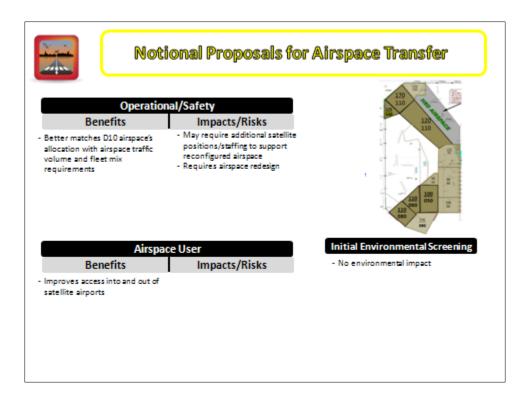


#### 4.3.2.3 Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

One impact of airspace transfer and reallocation is that it may change the workload at different control positions. This may require control positions that are already designed but not used on a regular basis to be staffed more often, or it may require a sector redesign to accommodate the transfer and reallocation of airspace. Staffing and equipment considerations must be analyzed.

This change is not expected to have an environmental impact.



# 4.4 DAL Arrivals

# 4.4.1 Identified Issues: "Long and Low" Routing for DAL and Satellite Jet Arrivals

A safety concern was identified for DAL and satellite airport arrivals. Aircraft descend inside D10 airspace, outside of Class B airspace and the 30 NM Mode C Veil, which exposes these aircraft to visual flight rule (VFR) traffic. Additionally, these routes are inefficient for jet aircraft since they fly at 4,000 or 5,000 ft for long distances.



Long and low routing for jets at 040 to DAL/East Satellite airports (primarily from the west side of D10)), outside of Class B airspace and 30NM Mode C Veil. Similarly long/low route for West Satellite airports from east side of D10



# 4.4.2 Study Team Recommendations: Segregated DAL RNAV Jet Arrivals

The PST recommends the creation of new RNAV DAL jet routes from the northwest and southwest, segregated from the DFW primary arrival flows. The conceptual design delivers DAL jets over MOTZA from the northwest on both North and South Flows, and over SLUGG from the southwest on only a South Flow.

Additionally, the PST recommends the addition of jet corridor notation on the Terminal Area Chart (TAC) used by VFR traffic to notify them that jet traffic can be expected to fly outside of Class B airspace and the 30 NM Mode C Veil at 4,000 and 5,000 ft.

To accommodate DAL arrivals when MOTZA or SLUGG are unavailable, the PST also recommends creating RNAV versions of the GREGS and KNEAD STARs that terminate near the D10 boundary.

As an alternative to the current routes flown outside of Class B and the Mode C Veil, the PST recommends that the D & I Team conduct a further feasibility analysis to examine the possibility for alternate arrival routes that enter D10 in a different location, at higher altitudes. A possibility for this further feasibility analysis is described in the upcoming East/West Satellite section of this document.

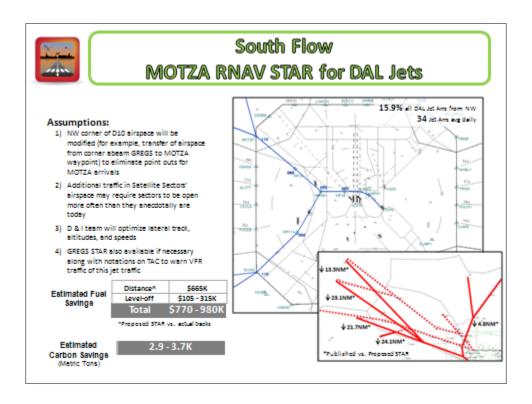
#### 4.4.2.1 South Flow MOTZA RNAV STAR for DAL Jets

The northwest corner post is currently the least frequently used by DAL, with 15.9 percent of DAL jet arrivals, about 34 per day. The proposed DAL RNAV STAR from the northwest routes arrivals over MOTZA at the D10 boundary instead of over GREGS. This may require a transfer of airspace from D10 to ZFW for the corner abeam GREGS to MOTZA to eliminate point outs for MOTZA arrivals.

The routing inside D10, which takes DAL arrivals over the top of DFW, is a much more direct route than the current GREGS route in South Flow, saving approximately 17 NM within D10 airspace. In ZFW airspace, the proposed MOTZA routing saves additional miles from the westernmost transitions, but increases distance flown in ZFW for the transitions farther north. The total mileage savings for the proposed STAR compared to the published route in ZFW and the vectored tracks inside D10 is 24.1 NM from the Guthrie (GTH) transition, 21.7 NM from TXO, 23.1 NM from Panhandle (PNH), 13.5 NM from BGD, and 4.6 NM from IRW and TUL. The distance savings from the proposed STAR compared to actual flown tracks is expected to result in an annual benefit of \$665K due to a reduction in fuel for DAL arrivals.

In addition to the fuel savings from a reduction in distance flown, the reduction of time in level flight on the proposed South Flow MOTZA STAR is estimated to result in a savings of \$105–315K per year. The proposed routing from BGD, PNH, TXO, and GTH was designed to be separated from the DFW arrival stream, allowing for a more constant descent in ZFW airspace, but no level-off benefit was calculated for this portion of tracks, as there were already limited level segments for DAL arrivals in ZFW and it was unclear how the new routing would be impacted by other traffic flows. The reduction in distance and time in level

flight results in a total estimated annual savings of \$770 - 980K, and an estimated annual reduction in CO2 emissions of 2.9 - 3.7K metric tons. This proposal is summarized in the graphic below.

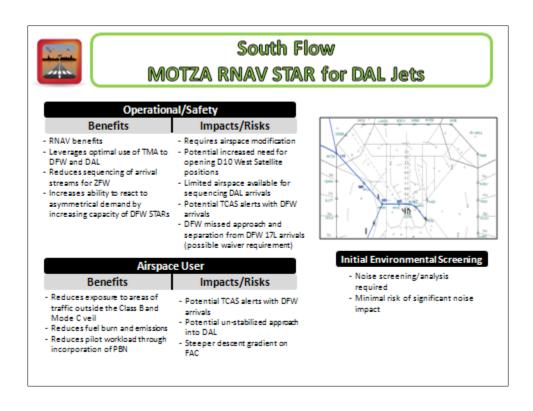


The graphic below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The South Flow MOTZA RNAV STAR proposal provides RNAV benefits, leverages optimal use of TMA to DFW and DAL by segregating the arrival flows, reduces sequencing of arrival streams for ZFW, and increases the ability to react to asymmetrical demand by increasing the capacity of DFW STARs. Potential impacts and risks of the proposal include an airspace modification that gives some of D10 airspace to ZFW and the potential need for increased opening of the D10 West Satellite positions since a new arrival stream will be going through this airspace. Impacts and risks regarding sending additional DAL traffic over the top of DFW include the limited airspace available to sequence DAL arrivals, potential Traffic Alert and Collision Avoidance System (TCAS) alerts with DFW arrivals, and DFW missed approach separation from DFW Runway 17L arrivals.

For airspace users, the benefits of the MOTZA RNAV procedure are the reduced exposure to areas of traffic outside the Class B and Mode C veil, reduction in fuel burn and emissions, and reduction in pilot workload through the incorporation of PBN. Impacts to the users include potential TCAS alerts with DFW arrivals, potential un-stabilized approaches into DAL, and a steeper descent gradient on the Final Approach Course (FAC).

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.

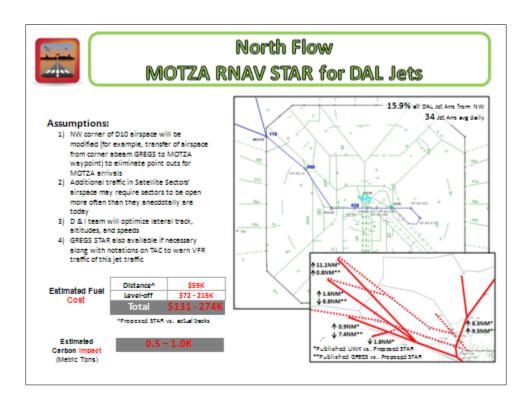


#### 4.4.2.2 North Flow MOTZA RNAV STAR for DAL Jets

A DAL MOTZA RNAV STAR has also been proposed for a North Flow, to segregate DAL arrival traffic from the UKW arrivals into DFW while still providing a safer, more efficient routing than the GREGS. A depiction of this STAR is shown in the graphic below.

Comparing the MOTZA RNAV STAR on a North Flow to the UKW published procedure, the MOTZA route decreases flying distance by 1.8 NM from GTH, and increases flying distance by 0.9 NM from TXO, 1.6 NM from PNH, 11.1 NM from BGD, and 8.3 NM from IRW and TUL. Compared to the GREGS procedure on a North Flow, the MOTZA route decreases flying distance by 7.4 NM from TXO and 8.8 NM from PNH, and increases flying distance by 0.8 NM from BGD, and 9.5 NM from IRW and TUL. Comparing the MOTZA route against actual flying distances, the proposed procedure results in an estimated annual cost of \$59K.

There is also an increase in time in level flight on the proposed MOTZA STAR compared to the UKW route, estimated to result in a cost of \$75-215K per year. The increase in distance and time in level flight results in a total estimated annual cost of \$131-274K, and an estimated annual increase in CO2 emissions of 0.5-1.0K metric tons.

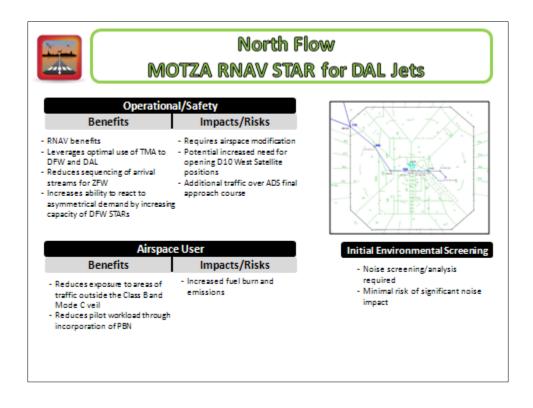


The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

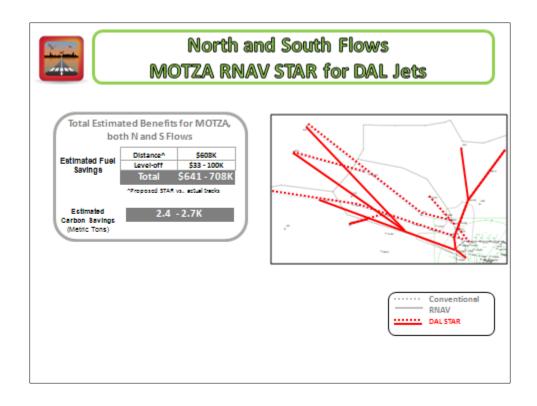
The North Flow MOTZA RNAV STAR proposal provides similar benefits as those on South Flow, through the incorporation of RNAV and the segregation of arrival flows from DFW and DAL. An additional risk associated with the North Flow routing is that there is increased traffic over the ADS FAC.

For the airspace user, the MOTZA RNAV route reduces exposure to Class B and the Mode C Veil and reduces pilot workload through the incorporation of PBN, but increases fuel burn and emissions compared to the current UKW arrivals.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



The DAL MOTZA RNAV STAR provides an overall benefit; the proposed design of this STAR in ZFW is shown below, along with estimated fuel and carbon savings. The reduction in distance and time in level flight results in a total estimated annual savings of \$641 - 708K, and an estimated annual reduction in CO2 emissions of 2.4 - 2.7K metric tons.

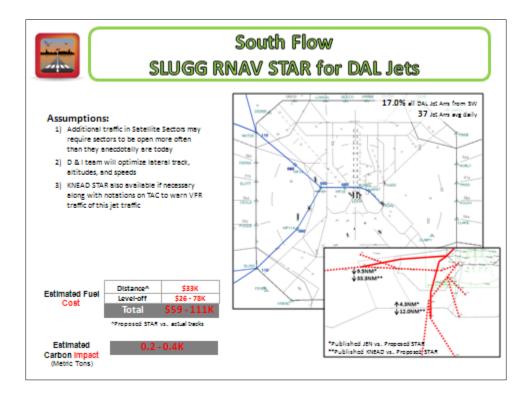


#### 4.4.2.3 South Flow SLUGG RNAV STAR for DAL Jets

The southwest corner post is currently the second least frequently used by DAL, with 17 percent of DAL jet arrivals, or about 37 per day. The proposed DAL RNAV STAR from the southwest sends arrivals over SLUGG at the D10 boundary instead of on the JEN or KNEAD STARs. The routing inside D10 takes a slightly longer path than the current JEN arrival, but enables the MOTZA route to be flown.

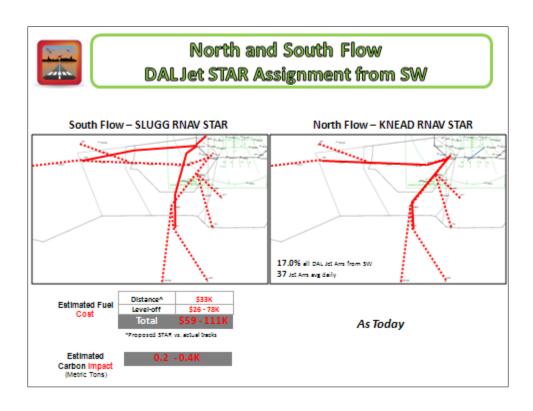
The proposed SLUGG RNAV STAR, depicted in the graphic below, is 9.5 NM shorter than the route from the INK transition, but 4.3 NM longer from AGJ than the published JEN arrival. Compared to the KNEAD arrivals, the SLUGG route is 33.3 NM shorter from INK and 12.0 NM shorter from AGJ. Compared to flown tracks, most of which take the JEN during VFR conditions and are shortcut along the procedure, the distance of the SLUGG results in an estimated annual fuel burn cost of \$33K.

In addition to the cost from an increase in distance flown, the change in the vertical profile of the SLUGG compared to the JEN and KNEAD arrivals results in an annual cost of \$26 - 78K per year. This results in a total estimated annual cost of \$59 - 111K, and an estimated annual increase in CO2 emissions of 0.2 - 0.4K metric tons.



### 4.4.2.4 North and South Flow DAL Jet STAR Assignment from SW

Routing DAL arrivals over the SLUGG on a North Flow to join the MOTZA arrival stream would add excessive distance and negatively impact the arrival profile, so the PST recommends creating an RNAV procedure for the KNEAD STAR in a North Flow configuration. The graphic below depicts the proposal for DAL Jet arrivals from the southwest corner on both flows, along with the estimated annual cost.



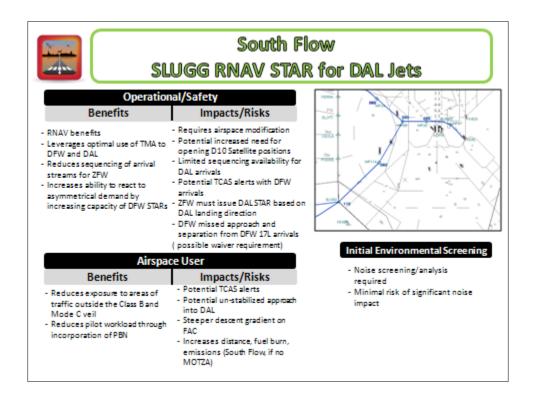
#### 4.4.2.5 South Flow SLUGG Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The SLUGG RNAV STAR for DAL jets provides RNAV benefits, leverages optimal use of TMA to DFW and DAL by segregating the arrivals, reduces sequencing of arrival streams for ZFW, and increases the ability to react to asymmetrical demand by increasing the capacity of DFW STARs. The route may require airspace modification inside D10, and will require ZFW controllers to issue the appropriate DAL STAR based on the airport flow. Impacts and risks regarding sending additional DAL traffic over the top of DFW include the limited airspace available to sequence DAL arrivals, potential TCAS alerts with DFW arrivals, and DFW missed approach separation from DFW Runway 17L arrivals.

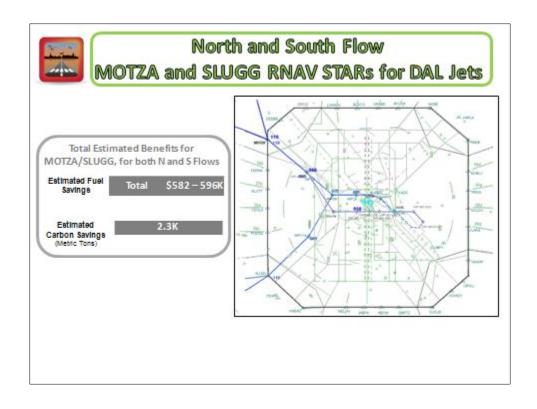
For airspace users, the benefits of the MOTZA RNAV procedure are the reduced exposure to areas of traffic outside the Class B and Mode C Veil and the reduction in pilot workload through the incorporation of PBN. Impacts to the users include potential TCAS alerts with DFW arrivals, potential un-stabilized approaches into DAL, a steeper descent gradient on the FAC, and increased distance, fuel burn, and emissions compared to the JEN arrival.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



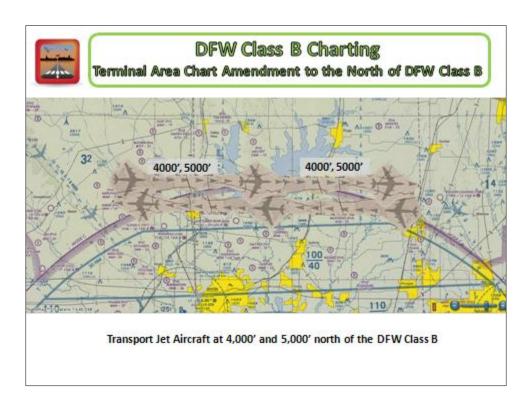
#### 4.4.2.6 North and South Flow MOTZA and SLUGG Benefits

As depicted in the graphic below, the total estimated annual benefit for the MOTZA and SLUGG routes, for both North and South Flows, is a savings of \$582 – 596K in fuel and a reduction of 2.3K metric tons of CO2.

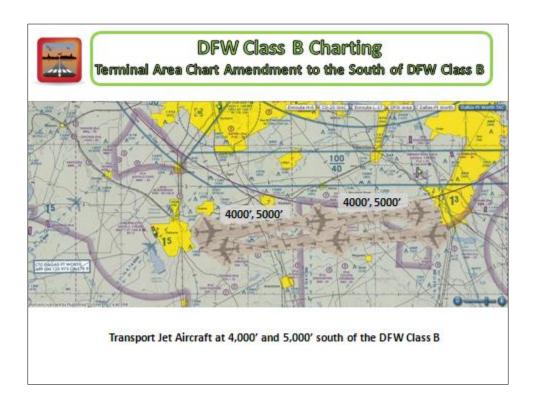


### 4.4.3 Study Team Recommendations: DFW Class B Charting

TACs depict information of interest for aviators flying visually in and around busy terminal areas. STARs to the primary airport are generally depicted by blue-colored jet aircraft and include directional arrows and altitudes. A significant amount of D10 jet satellite traffic is transitioned at 4,000 and 5,000 ft just north of the DFW Class B boundary and outside the Class B Mode C Veil. The PST recommends that this route be displayed on the DFW TAC. The graphic below shows a notional depiction of the proposed modification to the TAC chart to the north of DFW Class B airspace.



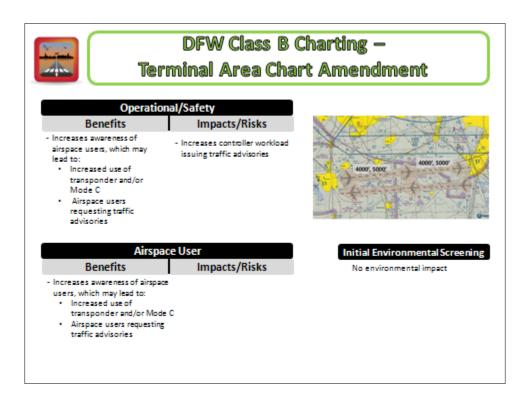
TACs depict information of interest for aviators flying visually in and around busy terminal areas. STARs to the primary airport are generally depicted by blue-colored jet aircraft and include directional arrows and altitudes. A significant amount of D10 jet satellite traffic is transitioned at 4,000 and 5,000 ft just south of the DFW Class B boundary and outside the Class B Mode C Veil. The PST recommends that this route be displayed on the DFW TAC. The graphic below shows a notional depiction of the proposed modification to the TAC chart to the south of DFW Class B airspace.



The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The depiction of the east-west/west-east routes north and south of the DFW Class B on the DFW TAC is anticipated to increase pilot awareness of jet aircraft transitioning this area at 4,000 and 5,000 ft. It may also increase the use of transponders in an area where they are not required. Additionally, it may lead to increased requests for traffic advisories in these areas and D10 may have to monitor this demand.

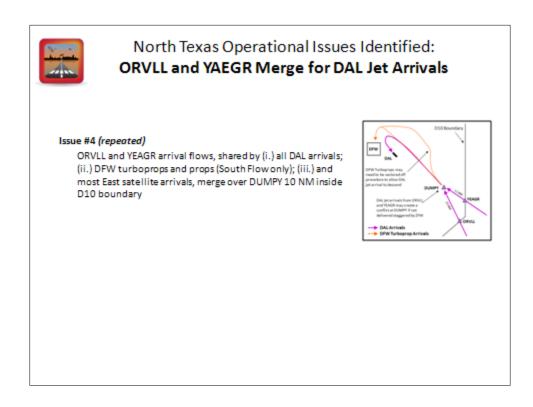
This change is not expected to have an environmental impact.



# **4.4.4 Identified Issues: ORVLL and YAEGR Merge for DAL Jet Arrivals**

The merge of the DUMPY STAR sometimes creates sequencing issues at DUMPY. Currently the ZFW/D10 LOA requires that ZFW provides in-trail separation at DUMPY when feeding the two arrival flows over ORVLL and YEAGR. The mix of aircraft types and the number of different airports that are sequenced into this arrival can make it difficult to provide proper in-trail spacing over DUMPY.

ZFW is required to manage this merge at DUMPY so that aircraft over ORVLL and YEAGR are separated at DUMPY. However the airspace could be more efficiently managed if these two arrival streams did not merge into a single stream inside D10 airspace. The graphic below depicts the merge of the YEAGR and ORVLL transitions over DUMPY. ORVLL and DUMPY are on the boundary of ZFW/D10 airspace.

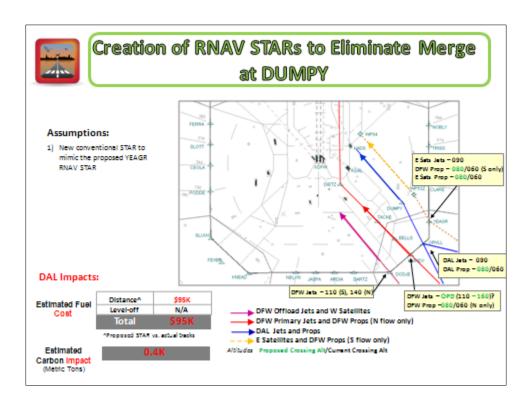


# 4.4.5 Study Team Recommendations: Creation of RNAV STARs to Eliminate DUMPY Merge

The PST recommends the creation of two RNAV STARs to eliminate the merge at DUMPY: (1) an RNAV STAR over YEAGR for east satellite jets and props, and on a South Flow only for DFW props; (2) an RNAV STAR dedicated to DAL jets and props over ORVLL. The segregation of DAL arrivals over ORVLL will allow for the optimization of TMA at this airport. Also, by eliminating the merge at DUMPY, sequencing for this merge will no longer be required by ZFW outside the ZFW/D10 boundary and by D10 inside the boundary.

The proposed "YEAGR" STAR, depicted in yellow in the graphic below, parallels the proposed "ORVLL" STAR (depicted in blue) and in this proposal is designed as an RNAV STAR. NAVAID limitations may not permit an overlay of a conventional STAR on the proposed YEAGR STAR. The cost of the proposal is approximately 95K and is estimated to result in an increase of .4K carbon emissions annually, since DAL arrivals that currently are routed from points east and north of YEAGR directly to YEAGR and then DUMPY are now routed directly to ORVLL and then DUMPY. Routing all DAL arrivals over ORVLL increases flying distance for the current DAL arrivals that fly over YEAGR. The benefits of the use of TMA for DAL arrivals on a segregated flow and the elimination of the merge over DUMPY appear to outweigh the additional cost of this procedure.

The proposed altitudes are notional and will be revised as required by the D & I Team.

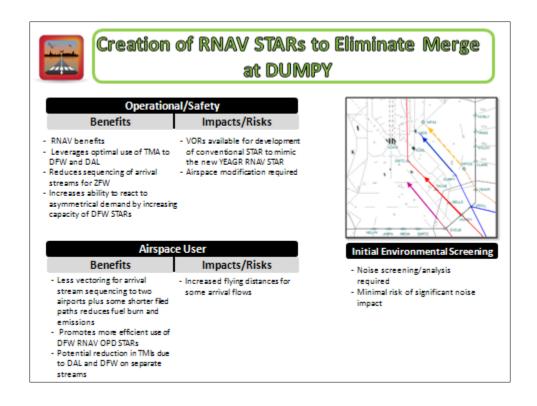


The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The ORVLL and YEAGR STARs provide RNAV benefits, leverage optimal use of TMA to DFW and DAL by segregating the arrivals, reduce sequencing of arrival streams for ZFW, and increase the ability to react to asymmetrical demand by increasing the capacity of DFW STARs. Impacts and risks include potential airspace modifications and the possible inability to create a conventional overlay on the proposed YEAGR STAR due to NAVAID limitations.

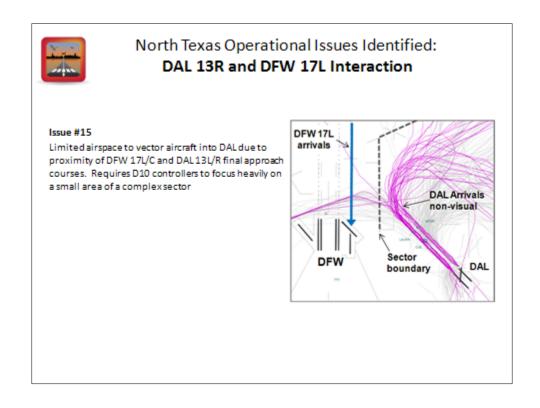
For airspace users, the benefit of the ORVLL and YEAGR STARs are more efficient use of the DFW RNAV OPD STARs, a potential reduction in TMIs due to the segregation of the DAL and DFW arrival streams, and less vectoring in ZFW airspace for in-trail requirements. Impacts to the users include increased flying distances for some arrival flows.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



#### 4.4.6 Identified Issues: DAL 13R and DFW 17L Interaction

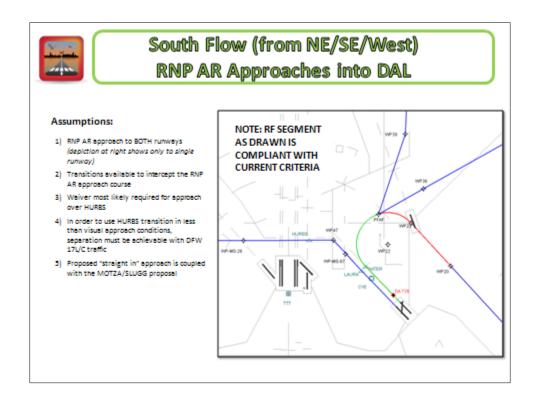
The close proximity of the DFW Runway 17L and DAL Runway 13 final approach courses requires a waiver to permit these approaches to be conducted simultaneously. The waiver requires that a monitor position be staffed to ensure DAL arrivals do not deviate toward the DFW Runway 17L arrivals. The sector boundary depicted below is approximately 2.5 NM from the DFW Runway 17L final and DAL arrivals must remain east of this line. This turnon area requires precise vectoring by D10 controllers and requires concentrated focus in this small area of a complex sector.



# 4.4.7 Study Team Recommendations: South Flow (from NE/SE/West) RNP AR Approaches into DAL

To assist the controller responsible for this traffic, the PST recommends the creation of RNP Authorization Required (AR) approaches into DAL on a South Flow. Aircraft performing RNP AR approaches fly precise paths with no vectoring required. These approaches would eliminate the need for controllers to vector (qualified aircraft) in a limited area and permit them to more optimally scan traffic and perform other operational duties in this busy satellite sector. This procedure may eventually eliminate the need for the monitor controller required by the waiver.

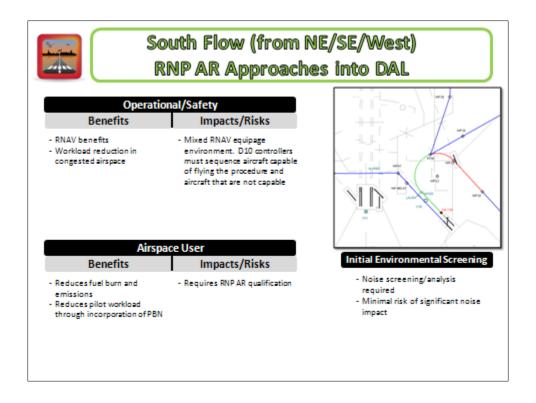
While not depicted in the graphic below, the RNP authorization required (AR) approach from the SE corner post would also serve Runway 13R at DAL. The procedure design would designate initial fixes (IFs) from the north (GREGS STAR traffic), from the northeast (FINGR STAR traffic), from the southeast (DUMPY/proposed ORVLL and KNEAD STAR traffic) and from the west (proposed SLUGG and MOTZA STAR traffic). Controllers would be able to clear arrivals direct to these IFs and the aircraft would fly the RNP path to the runway. Vertical guidance would be designed to comply with airspace restrictions. It is anticipated that Relative Position Indicator (RPI) may eventually be incorporated in this procedure.



The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The transition (from the west) over the top of DFW will require additional investigation to mitigate issues with DFW Runway 17 arrivals. It appears that a non-standard descent profile may be required for the over the top straight-in approach to DAL. Currently it appears that this approach must be designed as an RNP AR approach, which requires specialized pilot training and aircraft equipment requirements. Southwest Airlines (SWA) and some of the DAL-based business jet aircraft would qualify to fly this approach, but controllers would still have to deal with a mixed environment of those aircraft authorized and not authorized to fly the procedure. It is anticipated that during visual approaches, aircraft would continue to be vectored as they are today. The possibility exists for the D & I Team to design an RNAV Visual Flight Procedure.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.

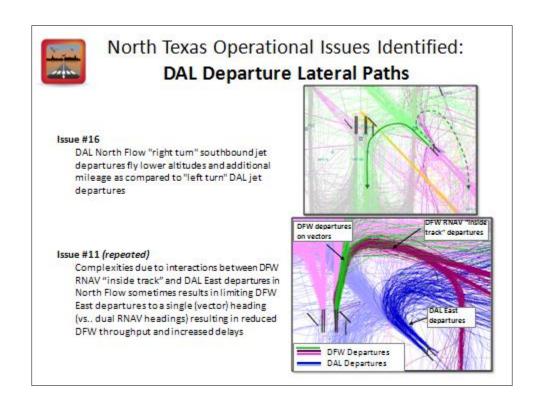


## 4.5 DAL Departures

#### 4.5.1 Identified Issues: DAL Departure Lateral Paths

DAL jet departures prefer to make a left turn over the top of DFW, represented by the green solid line in top depiction in the graphic below, when departing DAL Runway 31, as opposed to making a right turn (green dashed line) which increases flying distance and fuel burn. The availability of this left turn is normally predicated on aircraft climb rate and Runway 31 DAL arrivals over the top of DFW.

As shown in the bottom depiction in the graphic below, aircraft on the current conventional DAL jet departure SID have the potential to conflict with the DFW "inside track" departures if DAL departures are not vectored off the SID. Eastbound aircraft vectored off the DAL SID also have the potential to conflict with the DFW inside track departures depending on turn rate and controller performance. The interaction between the DFW inside track departures and DAL eastbound departures sometimes results in DFW departures being restricted to a single (vector) departure heading, as opposed to diverging dual RNAV courses. The loss of the dual headings reduces DFW departure throughput.



#### 4.5.2 Study Team Recommendations: DAL RNAV SIDS

To mitigate the issues described above, the PST recommends the creation of multiple RNAV SIDs for jet departures from DAL: (1) a North Flow left turn DAL RNAV SID for southbound traffic to address D10 airspace and DAL arrival traffic issues; (2) a North Flow right turn DAL RNAV SID to provide a predictable path and to procedurally separate DAL east departures and DFW "inside track" departures; (3) a North Flow DAL RNAV SID for west and northbound traffic which procedurally separates DFW and DAL traffic; (4.) a single South Flow DAL RNAV SID for all departures.

The DAL Runway 31 eastbound interaction issue and southbound (left turn) turn issue is addressed by the implementation of RNAV SIDs. Other (primarily in-trail requirement) issues may still impact the DAL eastbound/DFW inside track problem concerns. The safety concern of procedural separation of the two routes is mitigated. RNAV SIDs address Runway 31 departure issues to the east and south. In order to maintain consistency and ease of ATC operation, the PST recommends designing RNAV SIDs for all Runway 31 and Runway 13 departures. For example, if RNAV SIDs were available from Runway 31 and not available from Runway 13, aircraft must be issued a different SID dependent on direction, which creates additional ATC and pilot workload.

#### 4.5.2.1 North Flow DAL RNAV SIDs

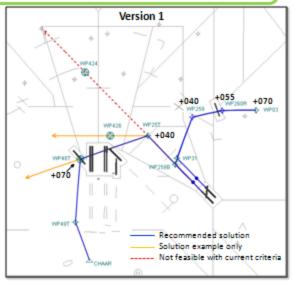
The graphic below depicts a notional design for the proposed DAL RNAV SIDs on a North Flow. The eastbound RNAV SID is designed to be procedurally separated from the DFW inside track (not depicted) and meet ADS and other satellite airspace constraints. The southbound RNAV SID is designed to be procedurally separated from DFW departures, DFW downwinds, and east/west DAL/satellite traffic over the top of DFW. The red dashed line represents the track that almost all west and north (Runway 31) DAL departures fly, however the PST was unable to procedurally separate aircraft on this track from DFW departures without potentially impacting DFW climb profiles. The PST designed two (yellow lines) potential alternatives for west and north DAL departures that enable procedural separation from (appropriate) DFW traffic. However, the intent would be that aircraft would only fly these procedures to WP25T as depicted below, except in the event of lost communications, and controllers would vector aircraft after crossing WP25T. This is the same procedure that is used for conventional procedures today. The RNAV SIDs deliver the benefit of a defined path east of the "drift line," which is a video map depiction of a lateral separation line between Runway 31 DAL departures and Runway 31R DFW arrivals.



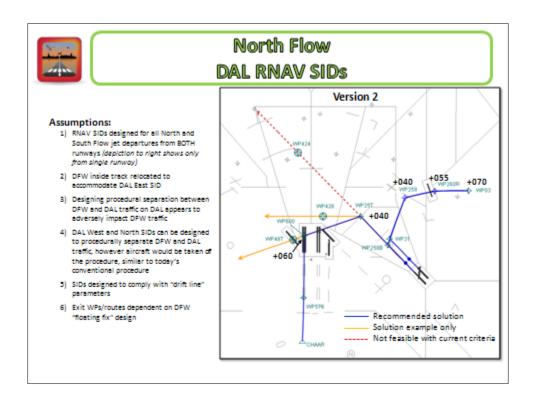
## North Flow DAL RNAV SIDs

#### Assumptions:

- RNAV SIDs designed for all North and South Flow jet departures from BOTH runways (depiction to right shows only from single runway)
- DFW inside track relocated to accommodate DAL East SID
- Designing procedural separation between DFW and DAL traffic on DAL appears to adversely impact DFW traffic
- 4) DAL West and North SIDs can be designed to procedurally separate DFW and DAL traffic, however aircraft would be taken of the procedure, similar to today's conventional procedure
- 5) SIDs designed to comply with "drift line" parameters
- Exit WPs/routes dependent on DFW "floating fix" design

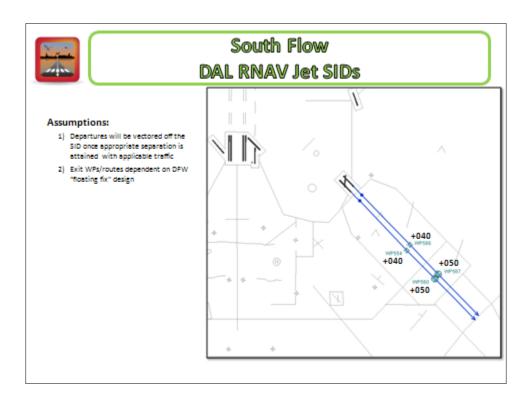


This graphic depicts a second version of the Runway 31 DAL (left turn) southbound RNAV SID. This proposed SID more closely follows the Spine Road track of today's vectored departures.



#### 4.5.2.2 South Flow DAL RNAV Jet SIDs

This is a notional depiction of the DAL Runway 13 RNAV SID. In today's conventional environment, jet departures are assigned runway heading and are turned on course once conflictions with other traffic are resolved. Typically the departures must climb above inbound traffic from the SE corner post before turning on course. The proposed RNAV SID overlays the conventional SID track off the runway and aircraft would expect vectors to their departure WP/route. The complexity of the satellite airspace does not appear to permit defined RNAV paths to the ZFW/D10 boundary.



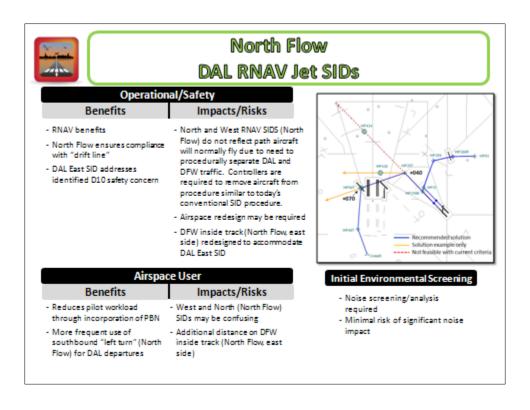
#### 4.5.2.3 Benefits, Impacts, and Risks

The slide below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The primary focus of the DAL RNAV SID concept is to address the DFW inside track and DAL eastbound departure issue, and the consistency of the DAL Runway 31 southbound turn issue. The RNAV SIDs provide predictable routing, procedural separation, and reduced pilot workload in these situations. Providing an RNAV path that complies with the drift line requirements is an added bonus.

The airspace complexities caused by the close proximity of DFW and DAL requires that different type RNAV SIDs be designed depending on the direction or route of the flight. This may add confusion and must be weighed against the advantages of the DAL Runway 31 east and south proposed RNAV SIDs.

An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



#### 4.6 East/West Satellite Arrivals

# 4.6.1 Identified Issues: "Long and Low" Routing for DAL and Satellite .Iet Arrivals

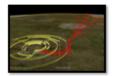
Jet traffic on the satellite STARs is typically descended to 4,000 or 5,000 ft just outside of both Class B airspace and the 30 NM Mode C Veil. This exposes jet aircraft to VFR traffic that are operating outside Class B airspace. Jet aircraft are generally forced down to these lower altitudes to remain below DFW arrival traffic on the low-side corner posts and below departure traffic on the high-side corner posts. Additionally, these routes are inefficient for jet aircraft due to the distances they fly at 4,000 or 5,000 ft. The graphic below summarizes this issue.



# North Texas Operational Issues Identified: "Long and Low" Routing for DAL and Satellite Jet Arrivals

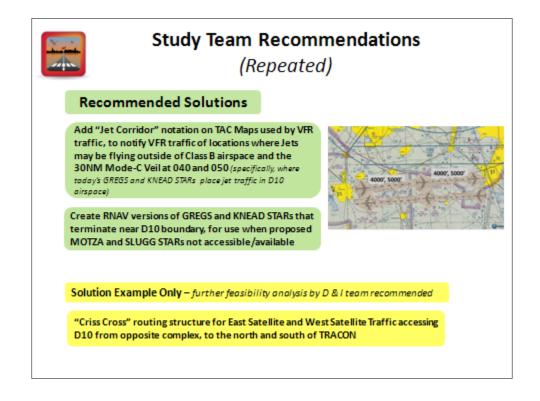
#### Issue #14 (repeated)

Long and low routing for jets at 040 to DAL/East Satellite airports (primarily from the west side of D10)), outside of Class B airspace and 30NM Mode C Veil. Similarly long/low route for West Satellite airports from east side of D10



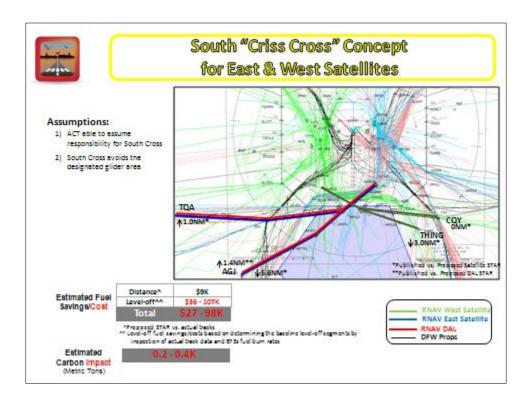
#### 4.6.2 Study Team Recommendations: Potential Satellite "Criss Cross"

The slide below summarizes solution concepts that were addressed in earlier sections of this document. The solutions described in the green boxes are recommendations by the PST. What is described in the yellow box below requires further feasibility analysis by the D & I Team to determine if the suggestion is viable.



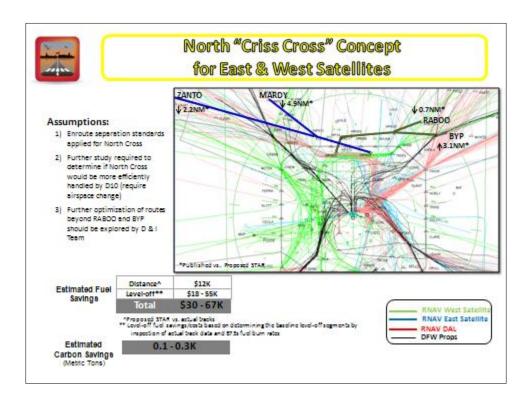
#### 4.6.2.1 South "Criss Cross" Concept for East and West Satellites

The slide below depicts a notional concept that requires a feasibility analysis by the D &I Team. This "Criss Cross" concept south of D10 incorporates delivering jet traffic inbound to DAL and satellite airports through Waco Approach Control airspace as opposed to via the KNEAD and DODJE STARs. The objective of this concept is to eliminate the "long and low" east and west routing just outside D10 Class B airspace. Waco controllers would receive jet traffic directly from ZFW, descend the traffic, and hand the aircraft off to D10 on the appropriate east or west side nearest their destination airport. Initial benefit calculations indicate that there is a small benefit in estimated fuel savings, however over-all estimates indicate a cost is associated with this concept, as noted in the graphic below. These costs must be weighed against the safety concern regarding aircraft transitioning at 4,000 and 5,000 ft outside the Class B airspace.



#### 4.6.2.2 North "Criss Cross" Concept for East and West Satellites

The "Criss Cross" concept north of D10, depicted in the graphic below, incorporates ZFW delivering jet traffic inbound to DAL and satellite airports on the appropriate east or west side nearest their destination airport, as opposed to via the JONEZ and GREGS STARs. The objective of this concept is to eliminate the "long and low" east and west routing just outside D10 Class B airspace. Initial benefit calculations indicate that there are small benefits in estimated fuel and level-off savings. A further feasibility analysis is required by the D & I Team to determine whether additional benefits may be gained by transferring some airspace to the north from ZFW to D10. This may permit terminal separation standards to be used in the area where the routes "Criss Cross," resulting in additional efficiencies and benefits.

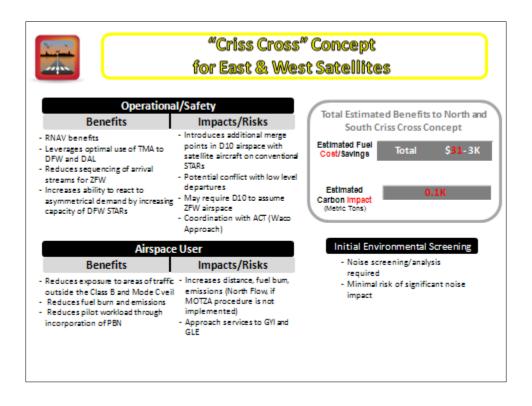


#### 4.6.2.3 Potential Benefits, Impacts, and Risks

The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The benefits gained include the predictability and reduced workload of RNAV procedures as well as the benefits previously discussed regarding segregation of flows. The concept also addresses the "long and low" issue just outside Class B airspace that was previously identified. The south cross requires coordination with Waco Approach Control to determine if any additional costs, i.e. staffing, equipment, etc. would be associated with this concept. The east and west flows of arrival traffic near the D10 airspace boundary may cause issues with departures that are traversing these areas at or below 12,000 ft. Initial estimates show that approximately 75 departures per day fly through each criss cross area. North Texas Regional/Perrin Field (GYI) and Gainesville Municipal (GLE) are airports with limited IFR activity that underlie the criss cross area to the north and may be a factor if D10 is delegated airspace to the north.

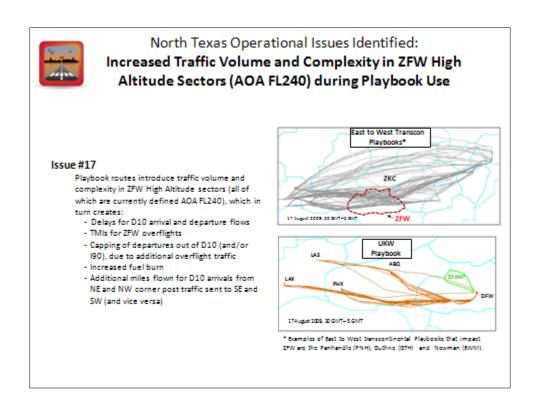
An initial environmental screening indicates that a noise screening or analysis is required. Minimal risk of significant noise impact was also indicated.



## 4.7 En Route Airspace

# 4.7.1 Identified Issues: Increased Traffic Volume and Complexity in AFW High Altitude Sectors (AOA FL240) during Playbook Use

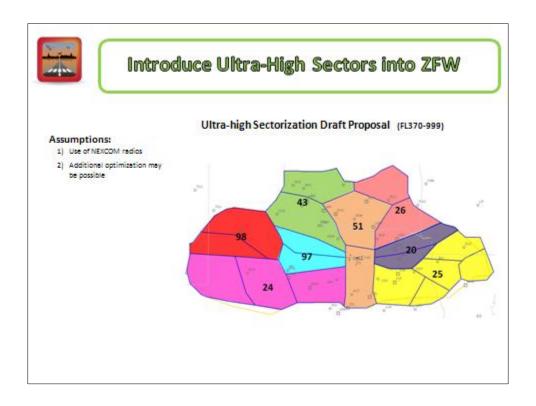
The PST identified increased traffic volume and complexity in ZFW high altitude sectors as an issue. The increased traffic volume and complexity in ZFW high altitude sectors typically occurs during times when playbook and Severe Weather Avoidance Program (SWAP) routes are implemented in the NAS, as these initiatives will shift transcontinental traffic into ZFW airspace. This additional traffic often results in the implementation of TMIs to manage complexity and traffic volume in ZFW high altitude sectors. The TMIs typically result in delays for arrivals into and departures out of D10's airspace; capping of D10 departures at lower altitudes; and additional flight times and distances for D10 traffic as well as ZFW over-flights, all of which translates into increased fuel burn. This issue is summarized in the graphic below.



# **4.7.2** Study Team Recommendations: Introduction of Ultra-High Sectors into ZFW

The PST recommends the implementation of ultra-high sectors in ZFW airspace.

A draft proposal for ultra-high sectors is shown below. This proposal would add eight ultra-high sectors that overly ZFW's existing high sectors. Eight frequencies have already been identified for these eight sectors, and the required hardware for all eight positions also already exists within ZFW. Note: additional optimization of the proposed draft sectorization may be possible.



#### 4.7.2.1 Impacts of No ZFW Ultra-Highs

All four of the ARTCCs surrounding ZFW contain ultra-high sectorization. This slide describes one kind of impact to the NAS that results from the absence of an ultra-high sectorization in ZFW.

During a normal "good weather" day such as August 24, 2009, shown in the top two depictions in the graphic below, when no playbook routings were in place, transcontinental traffic between the New York and Washington DC airports and Los Angeles (LAX), Las Vegas (LAS), Phoenix (PHX) and San Diego (SAN) airports typically fly through Kansas City ARTCC's (ZKC) airspace. Also during a normal day, D10 arrivals from LAX, LAS, PHX and Albuquerque (ABQ) typically enter D10 airspace over the NW corner post through ZFW sector 47 (Wichita Falls) airspace.

In contrast, on August 17, 2009, shown in the bottom two depictions in the graphic below, playbook re-routes were implemented for east to west transcontinental traffic due to convective weather in ZKC. The implementation of these playbook routes resulted in additional traffic and complexity in ZFW high altitude sectors. Due to the additional traffic volume in ZFW sector 47, the UKW playbook was implemented. It is important to note that this playbook was not put into place to reroute flights around convective weather, but rather to reroute traffic out of ZFW 47 in order to manage traffic volume and complexity that was introduced into this sector. This UKW playbook resulted in additional flight distances and fuel burn for D10 arrivals. The presence of ultra-high sectors would have most likely prevented the need to implement the UKW playbook to protect ZFW 47.

The operational impact of this example does not include other potential operational impacts from the implementation of playbook and SWAP re-routes, such as:

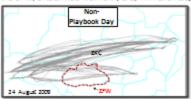
- Delays for D10 arrival and departure flows
- TMIs for ZFW overflights
- Capping of departures out of D10 (and possibly Houston Approach Control as well), due to additional overflight traffic

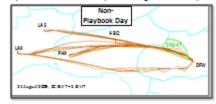


# Assessing Benefits of Ultra-highs Impacts of No ZFW Ultra-highs

#### Non Playbook Day (normal day)

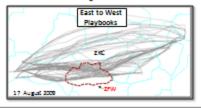
- During good weather days, transcontinental flights typically transition east to west through ZKC airspace
   And DFW/DAL arrivals from LAX, LAS, PHX and ABQ typically use D10's NW corner post through ZFW47 airspace

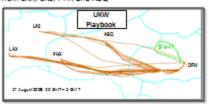




#### East to West Playbook Day (impacted day)

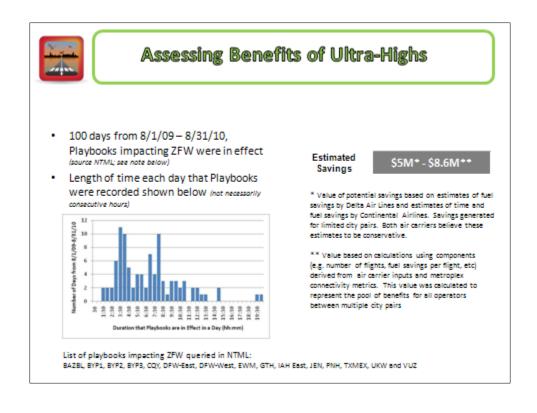
- Playbooks have shifted east to west transcontinental traffic from ZKC into ZFW due to convective weather in ZKC
   Due to the shift of transcontinental traffic into ZFW airspace, the UKW Playbook was implemented to manage ZFW47 traffic volume resulting in reroutes for D10 arrival flows from LAX, LAS, PHX and ABQ





#### 4.7.2.2 Assessing Benefits of Ultra-Highs

Playbooks impacting ZFW were observed to occur about 1 day in every 4 days in NTML. The overall annual savings from the implementation of ultra-highs is estimated to be in the range of \$5M to \$8.3M, and is summarized on the graphic below. The lower end of the annualized savings range is based on estimates of fuel savings from Delta Air Lines and fuel and time savings from Continental Airlines, which are frequently impacted by TMI restrictions imposed on traffic flying into, out of, or through ZFW airspace. The upper end of the annualized savings range was derived from fuel- and time-cost estimates provided by carriers, as well as traffic volumes derived from metroplex connectivity metrics.



#### 4.7.2.3 Benefits, Impacts and Risks

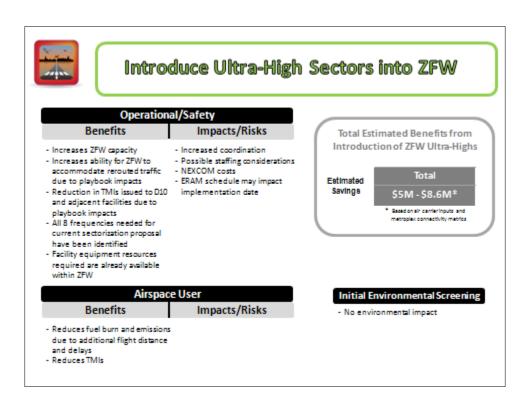
The figure below describes the qualitative benefits, impacts, and risks of the solution concept, both operationally and for airspace users.

The introduction of ultra-high sectors in ZFW airspace should result in increased airspace capacity and increased ability for ZFW to accommodate re-routed traffic as a result of playbook and SWAP re-routes. This in turn would reduce the need to issue TMIs to D10 as well as to adjacent facilities, resulting in fuel burn and flight time savings for both D10 and over-flight traffic.

Facility equipment resources that are required to implement eight ultra-high sectors is already available in ZFW. Also, all eight radio frequencies needed for the current ultra-high sectorization proposal have been identified.

The impacts and risks for the implementation of ultra-high sectors include the potential for additional coordination with adjacent sectors. There may also be staffing considerations for ZFW. It is assumed that the ultra-high sectors will use Next Generation Air/Ground Communication (NEXCOM) equipment, which does have associated costs. Lastly, the implementation schedule for ultra-highs may be impacted by the implementation of the En Route Automation Modernization (ERAM) system.

This change is not expected to have an environmental impact.



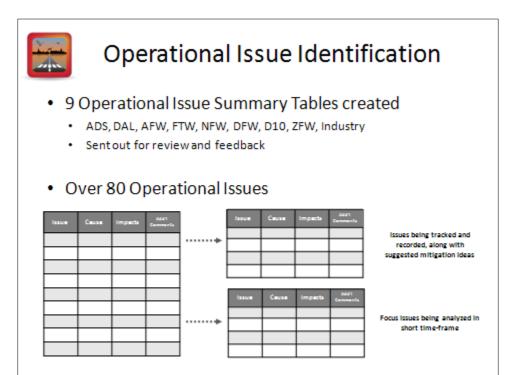
## 5 General Recommendations

Over the course of the project a number of general recommendations were provided to the PST that should be carried over to the Design and Implementation Team:

- PST conversations with ZFW Traffic Management Unit (TMU) personnel indicated that there was a disconnect regarding the coordination phrases for dual arrival route operations. A typical coordination issued by the D10 TMU is "6 X 10," which means 6 aircraft are permitted on the duals 10 miles-in-trail (MIT). The issue appears to be that this coordination does not contain enough specificity, and as a result some personnel at ZFW are not sure if the "6" aircraft apply over the course of the day, the next hour, the next push, etc. Additional specific coordination/clarification should resolve this issue.
- Changes in minimum vectoring altitude (MVA) criteria have removed a previously available altitude for some departure airports; for example, as a result of this criteria change ADS went from two departure headings to a single departure heading, and AFW is currently limited to 3,000ft as its only available departure heading. This results in less flexibility for D10 controllers to release satellite departures and potentially increased departure delays for some airports. It is recommended a review of satellite airspace be accomplished to determine if an airspace adjustment can be made to enhance satellite airport efficiencies.
- Numerous new RNAV routes have been proposed. An examination of the conventional procedures should be accomplished to determine if they could more closely duplicate the proposed RNAV routes to both promote efficiency and ATC consistency.
- There are significant benefits identified by high-side OPDs on the DFW STARs. The proposed low-side OPDs currently end at 9,000 ft. The opportunity may exist for these low-side OPDs to be extended to the appropriate final approach course.

# 6 Issues Not Analyzed by PST

The PST met with eight different facilities, listed in the graphic below, as well as Industry, to discuss North Texas Metroplex operational issues as well as solution ideas. These issues were recorded in tracking sheets and reviewed with the appropriate personnel for accuracy. Some suggested mitigation ideas were identified in the tracking sheets while others were addressed in the proposed solution concepts. These operational issues will be forwarded to the appropriate North Texas Metroplex management personnel and may serve as a cornerstone for local and/or district initiatives. The tracking sheets will also be provided to the D & I Team.



The PST addressed solution concepts that were achievable in a 2-3 year time frame. Longer term solution concepts were discussed, but implementation was not thought to be achievable in the designated time frame. These solution concepts include:

- The wide downwind concept, which consisted of taking DFW arrival aircraft on the high-side STAR directly from the ZFW/D10 airspace boundary to a base leg entry point. This concept moves the "modified" downwind further from the airport, potentially allowing departures to consistently top the downwind stream. Arrivals would be on an OPD and departures on an optimized profile climb (OPC).
- Another concept that was discussed was to expand terminal airspace, primarily over the corner posts. This may permit additional flexibility in arrival airspace design and may permit additional use of dual arrival streams.
- The straight in arrival concept proposed that a "high and wide" STAR be created to feed DFW arrivals straight in to the center runway during "triple" approaches. This could eliminate congestion in D10 airspace and eliminate some of the noted upwind/downwind vectoring that occurs in D10 airspace.
- The 45-degree rotation concept involved arrivals inbound from the four cardinal directions and departures departing the current corner posts. This approach may more readily promote OPCs.
- Lastly, DAL has significant air carrier traffic but it is not designated as a Class B
  primary airport. Consideration should be given to including DAL as a primary
  airport and expanding Class B airspace to accommodate DAL operations.

## 7 Summary and Results

The objective of the PST was to identify and address operational issues through the application of PBN procedures and airspace changes that enable predictable, repeatable flight paths, reduce ATC task complexity, and maximize efficiency

These tasks were accomplished by (1) collaboratively identifying and characterizing existing issues and (2) proposing conceptual designs and airspace changes that would address the issues and help to optimize the operation.

The PST also estimated expected benefits from solution proposals by quantifying the annual differences in fuel burn between the current operation and the proposed changes. Additionally, the PST identified risks and other considerations, including environmental, associated with the proposed conceptual designs.

Adopting the PST recommendations is estimated to result in an annual savings of \$10.3 – 21.7M, primarily due to fuel savings from the use of OPDs and reduced track distances and the introduction of ultra-high sectors. The PST recommendations are also likely to result in other benefits, including laying a foundation for NextGen capabilities, providing repeatable and predictable flight paths, reducing ATC task complexity and pilot/controller

communications due to reduced radar vectoring, reducing the need for TMIs, and improving situational awareness for VFR traffic. The graphic below summarizes these results.



## Results

 Adopting the recommended changes proposed by the North Texas Metroplex Prototype Study Team is estimated to result in an annual savings of between \$10.3 and \$21.7 million per year, primarily due to

#### Fuel Savings from Use of OPDs and Reduced Track Distances

Neduced Hack Distances	
DFW Departures	\$0.7 - 1.0M
DFW Arrivals	\$4.1 - 11.6M
DAL Arrivals	\$0.5 M

#### Introduction of Ultra-High Sectors

ZFW Ultra-Highs	\$5.0 - \$8.6M*
* Based on air carri	er inputs and metroplex
	connectivity metrics

Total Estimated Benefit	\$10.3 - 21.7M
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- Additional benefits include
  - Reduced ATC task complexity and pilot/controller communications due to reduced radar vectoring
  - Foundation for NextGen capabilities (e.g., use of Relative Position Indicator; Required Time of Arrival)
  - Repeatable, predictable flight paths
  - Reduced need for TMIs
  - Improved situational awareness for VFR traffic, thereby improving safety